UNIVERSITI TEKNOLOGI PETRONAS

"AUTISTHERAPIBOT: A New Robotic Approach for Autistic Children"

By

Muhamad Haris Bin Abdul Rahim 16756

A dissertation submitted to the
Information and Communication Technology Program
Universiti Teknologi PETRONAS
In partial fulfillment of the requirement for the
BACHELOR (Hons) OF TECHNOLOGY
(INFORMATION & COMMUNICATION TECHNOLOGY)

SEPTEMBER 2014

Universiti Teknologi PETRONAS
Bandar Seri Iskandar
31750 Tronoh
Perak Darul Ridzuan

CERTIFICATION OF APPROVAL

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Approved by,

_____
(Dr. Norshuhani Zamin)

Universiti Teknologi PETRONAS
Tronoh, Perak
SEPTEMBER 2014

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

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MUHAMAD HARIS BIN ABDUL RAHIM

ABSTRACT

Recent studies unravels that there are a lot of negative implications happen in those children who suffers from Autistic Spectrum Disorder (ASD) which include Asperger and Kanner Syndrome. All these syndromes shares similar characteristics which are difficulties in socialization, communications and repetitive inflexible behaviors. This problem leads to difficulties in learning especially to those children suffering from autistic disorder. Thus, the objective of this project is to investigate the current teaching method used by the autism therapists in Perak at the selected special school and is to develop an autonomous robotic system to aid the teaching and learning process of autistic children in Malaysia. The LEGO Mindstorm NXT is used as an alternative approach in educating those children with ASD namely those in the Asperger range since Asperger is more common compared to Kanner. The prototype, is tested on a group of autistic kids from selected public and private autism institution. The project focuses on how to attract the autistic children and sustain their learning via the usage of robotic application such as the LEGO Mindstorm NXT. In a preliminary investigation, multiple robotic designs and programming approach are experimented to produce a robotic application that can engage with the target autistic children in order to facilitate their process of learning via the intervention of their therapists. Interviews with the therapists and live observation at the selected special school are conducted to understand the traditional learning process that are used by the therapists and identify the weaknesses in it to improvise it. The results from the investigation and tests shows that this robotic systems helps a lot in assisting the therapist in educating autistic children and scores way better if compared to the current methods they are using. The significance of this robotic application is to fulfill the depravedness in the learning capabilities of the autistic children and also to assist the therapists in their daily routine.

ACKNOWLEDGEMENT

Firstly, as the author of this dissertation and the project, I would like to express my gratitude to Allah S.W.T for the benevolence and might that were given to me in order for me to successfully complete my project. Not to mention, my parents and family members for their continuous support, care and comprehension throughout the duration of completing this project.

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ABRREVIATIONS AND NOMENCLATURES

RAD	Rapid Application Development
ASD	Autistic Spectrum Disorder
SDLC	System Development Lifecycle
UTP	Universiti Teknologi PETRONAS
CIS	Department of Computer & Information Sciences

CHAPTER 1: INTRODUCTION

1.1 Background of Study

Children with Autistic Syndrome Disorder are facing problems in regards of their process of learning. This is due to the fact that those children who are suffering from ASD have morbid traits such as difficulties in communicating, socializing and repetitive inflexible behaviors. As a result, they are having a hard time grasping every knowledge that are taught by their therapists. This becomes even worse when even the therapists are having difficulties in disseminating knowledge to those kids since as a human being, we have our limits and they can't just comply with every demand these children made.

With the rise of robotic technology and Artificial Intelligence, we can apply this enhancement into the therapist teaching model so that this can improve the efficacy of their teaching greatly so that they wouldn’t face this kind of conundrum in the future. Plus, this also helps the autistic children to gain information more swiftly so that they can also one day stand on par with other normal kids out there.

1.2 Problem Statement

Autistic Syndrome Disorder or also known as ASD is a range of developmental disorder that occurs during pregnancy (National Center for Learning Disabilities, 2010). It is basically a disorder in the brain structure which leads to different perceptive and cognitive skills especially to those that have been diagnosed having ASD. ASD ranging from Asperger Syndrome which is the high functionality ASD till the low functionality ASD which is the Kanner Syndrome. The problem arise when the children who age from 3 to 12 who are suffering from ASD regardless of its level of severity having trouble in digesting information that are being taught by their respective therapists. There are a lot of children who are suffering from learning disability syndrome such as slow learner, down syndrome and so much more but it is more likely to say children with ASD are much harder to handle with other learning disability children. This is due to the fact that other learning disability only revolves their incapacity in their senses while their perceptive and cognitive skills are still normally intact and on par with regular kids out there. It is a different story altogether when it comes to kids with ASD because even though their five senses are normal, their central processing unit which is their brain are having difficulties in extracting all those sensory input coming from their five senses (Autism Society, 2006).

1.2.1 Difficulties in Communication

Children with autism tend to have a hard time especially when it comes to conversing with other individuals regardless of their gender, age, race, and others. They just can't maintain their concentration for long when facing other individuals. They're more likely to face an inanimate object when it comes to speaking with other people and when we talk to them, we must repeat several times to them so they can clearly understand what we are trying to convey to them (Lord et al.,1994). Plus, when we talk to them, we must always make sure that the words we are using are simple enough for them to understand and we must also not forget not to give them lots of instruction at one time or they'll fall in the state of outrage. Just give them one simple instruction at a time so they can properly digest the information we want to give them though the process will be quite time consuming.

1.2.2 Difficulties in Socializing

Children with ASD always have a difficult time when it comes to socializing with others. They tend to back away from socializing with each other and only care about their own thinking instead (Lord et al.,1994). It always becomes an awkward moment when other regular kids trying to bond with them but instead of receiving a warm reply, they just got ignored. That is one of the main reason why kids with autism nowadays are always being shunned and put at the sideline of the class (Lord et al.,1994).

1.2.3 Repetitive Inflexible Behavior

Repetitive inflexible behavior also falls under the attributes of those children who were diagnosed with ASD (Lecavalier et al.,2006). They tend to re simulate every single movement that pop up in their mind. They also have a hard time when it comes to copying other children's action like putting a geometrical block in their respective fittings, constructing a toy car, and much more. Once they've grasped one of the movement they intended to do they'll keep repeating on doing it and it becomes even worse when the therapist themselves having a hard time to teach them not to repeat their monotonous movement and do different movement instead (Lecavalier et al.,2006).

1.2.4 Complementing Autism Deficiencies via Color Differentiation Method

Even though with all the problems faced by the autistic children, they have a good tendency in distinguishing colors as mentioned by Michaud (2002), where they have a very sharp and keen eyesight due to the fact that their brain power were less invested in cognitive process, but in their sensory power instead. That is the primary motivation and challenge that drives the project into existence where putting their strength into good use may complement the lacking in their cognitive attribute.

1.3 Objectives of Study

1. To investigate the current teaching methods used by the autism therapists at the selected special school in Perak and compare it with the use of Robotic approach.
2. To develop an autonomous robotic system to aid the therapists in educating autistic children via the usage of color distinguishing method.
3. To evaluate the developed prototype with the target users. i.e. a group of autistic children from a selected school in Perak.

1.4 Scope of Study

The scope of this project is to emphasize on:

1.4.1 Characteristics of the Autistic Children

The primary focus of this project is to assist the therapists and not to substitute the therapists as human intervention is always the best method in teaching those autistic children. Robot simply doesn't have feeling which gives it an edge and at the same time it can be a disadvantage since robot can't teach the autistic children with compassion and care. The autistic children just can't handle the robotic application since the robot body is fragile and need to be handling with care and its only plausible if the therapists handle it instead since the behavior of autistic children is virtually unpredictable. Thus, the project will be focusing on aiding the deficiency in their characteristics such as communicational skills so that they can digest information taught by the therapists at a much faster rate via the assistance of the robotic application. Thus, Sekolah Kebangsaan Sultan Yussof was selected to test with the pilot test group which is the autistic children. Therefore, an approval letter was acquired in order to carry out the study. The approval letter from the Ministry of Education is attached in the appendix section.

1.4.2 Best Robotic Design for the Targeted User in a Specific Age Group

The design of the robot should be ergonomic enough to the users especially the autistic children's therapists and the autistic children themselves from the age group of 6 to 12 years old. The robot design should be able to captivate the children's attention so that the therapists can use the robot more effectively. The design should also be focus more on simplicity rather than complexity so it will give the impression of ease of use for the therapists to handle it. Lastly, the design should give the expected impact on both the therapists and the autistic child so that the robot meets its purpose of creation which is to deliver knowledge to the autistic child without burdening the therapists.

1.4.3 The Proper Functionality for the Robotic System That Best Serves the Targeted Age Group with Asperger

The autistic children loves to be given something as a reward for their effort in gaining something and the therapists is seeking something that can aid them in delivering knowledge and at the same time reward their patient namely the autistic kids for their sheer effort in accomplishing the task given to them. So, the focus here is to build a NXT robot with color sensor with the intent to aid the therapists to teach their patient about the insight on colors. For every task, accomplished the robot will perform something to them as a reward for their success. For this case, fan functionality will be executed every time the patient gives the correct answer to their respective therapists. This functionality will be solely targeted to those with Asperger Syndrome due to unavailability of those with Kanner Syndrome.

CHAPTER 2: LITERATURE REVIEW

2.1 Comprehending Autism and Autistic Spectrum Disorder (ASD)

Autistic Spectrum Disorders (ASD) are a collection of disorders with complex neurological development handicaps with real characters which incorporate social and correspondence limitation, tangible impedances and reiterative monotonous attitude (Virginia Department of Education, 2010). ASD is not an extraordinary ailment; it influences more or less 1 in every 165 persons (Autism Society, 2006). It happens regularly and distinguished in the child by age 3. ASD is otherwise called a deep rooted issue with no accurate cure. In any case, with prompt mediation and stern instructive practices, the kids may bring about fast change in a good way.

Kids with autism have some difficulty in conversing. They have some difficulty understanding what other individuals think and feel. This makes it hard for them to communicate either with words or through gestures, facial interpretations, and touch. A child with autism who is extremely touchy may be extraordinarily pained, in some cases even tormented by sounds, touches, smells, or sights that appear ordinary to others (WebMD, 2009). Child who is autistic may have dull, stereotyped body propagation, for example, shaking, pacing, or hand fluttering. They may have abnormal reactions to individuals, linkage to inanimate object, imperviousness to change in their schedules, or forceful or self-harmful conduct. Now and again they may appear to be not to recognize individuals, objects, or events in their surroundings. Some child with autism might additionally create seizures. Also in a few cases, those seizures may not happen until youth.

Numerous individuals with autism are cognitively impaired to some degree. Rather than more ordinary cognitive debilitation, which is described by moderately to even lagging in every aspect of improvement, individuals with autism show uneven aptitude advancement (WebMD, 2009). They may have issues in specific zones, particularly the capability to impart thoughts and relate with others. In any case they may have curiously created abilities in different zones, for example, drawing, making music, taking care of math issues, or retaining certainties. Therefore, they may test higher, maybe even in the normal or above-normal extend on nonverbal brainpower tests.

There are three primary issues considered subset of ASD, which are Autistic Disorder, Asperger's Disorder and Pervasive Developmental Disorder Not Otherwise Specified (PDD NOS) (Ontario Ministry of Education, 2007). The most well-known issue would be Autistic Disorder, consequently this paper will concentrate on the attributes and learning hypotheses of extremely autistic issue.

2.1.1 Attributes and Traits of Autistic Children

Consistently, individuals with autism always show that they are attempting and equipped to succeed, make up for and overall oversee various of autism' most bewildering features (Notbohm, 2013). This certainly tells that autism in all ages are attempting their best to have a standard day by day lives like other typical individuals. Autism' qualities might be ordered into three significant ranges: unusual/challenging behaviors, speech/dialect intrusions and impairments, and the indefinable social communication abilities (Notbohm, 2013). Despite the fact that these three essentials may be common to numerous autism, however not substantial number of autistic kids have the definite comparative qualities with one and another. Each autistic kid may demonstrate distinctive sorts of symptoms (AHRQ, 2011).

Autism differs gigantically in seriousness. People with extreme autism conditions may have genuine cognitive handicap, tangible issues and side effects of greatly monotonous and surprising behaviors. This can incorporate fits, harm toward

oneself, prevention and animosity created by a powerlessness to convey. Without fitting escalated mediation, these manifestations may be exceptionally steady and hard to change. Living or working with an individual with serious autism might be extremely difficult, obliging huge tolerance and understanding of the condition. In its mildest structure, in any case, extreme autism is more like an identity distinction brought about by troubles in understanding social gatherings.

Youngsters with ASDs create diversely and at distinctive rates from other kids their age in the territories of passive, dialect, cognitive and social abilities development. They may be great at cutting edge or complex abilities, for example, taking care of math issues yet find the "simple" things, such as talking or making companions' exceptionally troublesome. Some youngsters with ASDs create expansive vocabularies and can read long words yet may not able to vocalize the sound of a solitary letter. A child might additionally learn new aptitudes, for example, saying various words, yet lose this capability later on.

2.1.1.1 Repetitive and Inflexible Behaviors

Autistic kids may indicate unalike practices contrasted with a typical kid. Whether it may concern on the way they speak with others, engages on specific protests or individuals, and even in regular exercises. Case in point, they will regularly appear to be more open to playing alone and think that it more troublesome to play with other kids. This may come about because of their trouble to express their emotions and comprehension to others also. Some of other odd practices that may happen are fixation on one particular interest or inanimate object, rigidity to a schedule, and dreary practices (Alberta Learning, 2003). Autistic kid can structure a solid connection to a specific routine or object and get to be to astounding outrage once it is changed or erased. Also, they have an engagement to monotonous way of conducting themselves, for instance, fluttering arms, turning, shaking and over and over again asking the same inquiry (Millar, et al., 2002). Verifiably, autistic kid will act uniquely in contrast to an ordinary kid, accordingly the methodology to captivate and comprehend them will be vary from a typical kid.

2.1.1.2 Difficulties in Communication

Communication is the principal medium for people to associate with one another and to comprehend their surroundings. It is additionally a procedure of trading information and thoughts between two or more individuals. Accordingly it is basic for children to create their communication trait at a junior age. In any case, an alternate real setback of autistic children is their impedance in communication abilities. They are having some difficulty understanding other individuals and additionally passing on their thoughts and feeling to others. Furthermore, they have a postponement in the advancement of spoken language and in addition the ability to start or manage a discussion with the individuals around them (Brereton, 2011). This deferral incapable them to join with other kids, along these lines brings down their self-esteem and urges them to play alone in their own particular imaginative world. Furthermore, they have poor focus, consistent addressing or monotonous inquiring, and troubles in understanding forms of non-verbal communication languages like feelings, motions and eye contact (West Midlands, 2000). Subsequently, autistic children are not ready to have social holding and getting what they want and need.

2.1.1.3 Difficulties in Socialization

Socializing is an ability required for people to run their normal lives by understanding other individuals' necessities and yearnings, trading data, and dependence with one and another. Autistic kids face innumerable hindrances every day, however their complexities in socializing with individuals around them are generally difficult. Social interaction challenges incorporate inconvenience in associate collaboration, downside in utilizing and comprehending nonverbal communication, and limited impersonation of other's activities and sounds (Poliakova & Palkhivala, 2008). As they experience issues in peer communication, they have hard time in making companions and may not appear pulled in to doing so. On top of that, they are not able to perceive individuals' sentiments and activities, other than may express practically zero facial representations in light of others (Brereton, 2011). Subsequently, the incapacities to socialize with others might be annoying, to the autistic children alongside the individuals around them.

2.2 Autism in Malaysia

In 2007, approximately 1 in 150 children has been diagnosed with autism spectrum disorder (ASD) according to estimates originated from National Autism Society of Malaysia's Autism and Developmental Disabilities Monitoring (ADDM) Network (National Autism Society of Malaysia, 2013). From then, the rate of ASD prevalence rise up to 1 in every 110 children in the year 2009 and doubled in the year 2013. ASD may occur in anyone regardless of racial, ethnic and socioeconomic groups due to the nature of ASD occurring as a result from brain development mishaps. The case is on the rise maybe due to the unhealthy lifestyle of most parents nowadays.

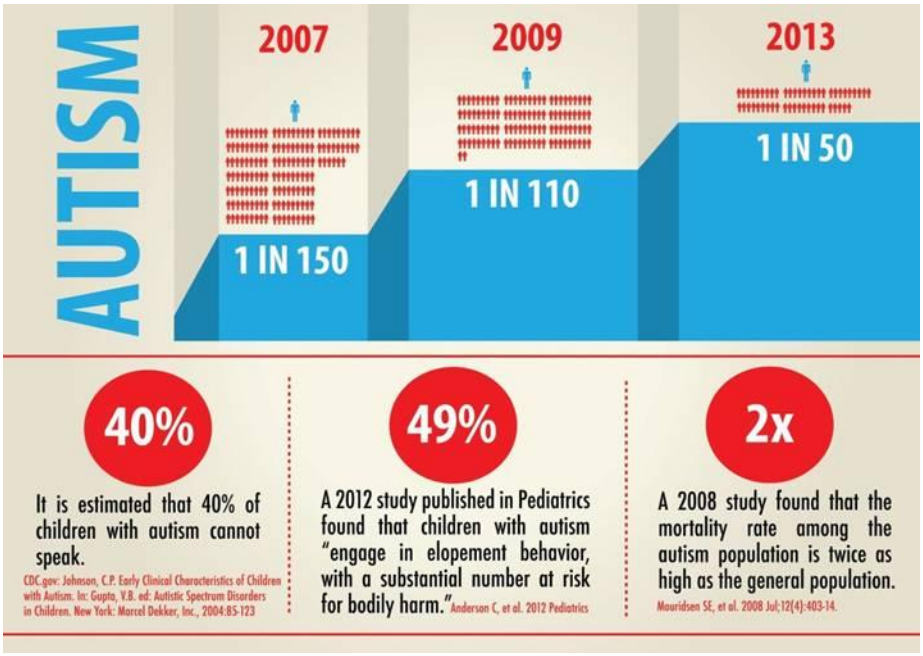


Figure 2.1: Average Malaysia prevalence of Autism Spectrum Disorder (National Autism Society of Malaysia, 2013)

According to CDC's data, ASD is almost 5 times more common among boys (1 in 42) than among girls (1 in 189) (Centers for Disease Control and Prevention, 2014). That is why parents with autistic children particularly in Malaysia are gravely concerned about their child's development and future since the data stated above also include Malaysia and the number of autistic cases in Malaysia is on the rise lately. It is estimated that 1 out of every 600 children in Malaysia is born with autism (The Malaysian Times, 2014). Recent statistics also reveals that nearly 47000 people in

this country are autistic (The Malaysian Times, 2014). Out of that number, it is approximated that 4 out of every 10000 suffer from severe autism such as Kanner Syndrome which is also known as the low functionality ASD (The Malaysian Times, 2014).

2.3 Successful Autistic People

Figure 2.2: Anthony Barrett (The left person who were giving the high five) is an autistic entrepreneurs (Global News, 2013)

Typical entrepreneurs will usually tell you that the first year is usually the most difficult time in regard of establishing a business. Well, one man from Edmonton who also has autism has been able to pull through his first year of business (Global News, 2013).

His mother realized that Anthony have a knack in delivering goods to other people. Thus, one of his friends Mikey Hamm helped him boost his business via video showcasing where he introduced him and his new courier service business named “Anthony At Your Service” to captivate the eyes of his potential customers (Global News, 2013).

This is easy for him to handle since Anthony loves going out and seeing new places and he also likes meeting people so that he can feel as if he’s being part of the community. The delivery business enables him to make some earnings and due to his perseverance, he’s been rewarded with loyal customers that are willing to help him improve his business further. Long story short, this shows that even people with

autism can make it out there in the big wide world and never underestimate their capabilities to excel in the real world since them also able to stand on par with other normal people. In fact, the most ironic part is that they are also people who are normal and yet they are worse compared to these kind of people namely Anthony who already proved to the world that he can do it if he’s willing to.

2.4 Focus Area of Education

Creating the abilities of autistic kids' day by day life is truly a test as each of them has diverse symptoms and is remarkable in their own particular ways. Regardless the efforts and practices done by parents, instructors and even experts to aid are non-stop and contrast as per each kid's practices and qualities. To help improve their life's quality, there are few real zones of education that must be thought to. Those ranges are communication, social and independence.

2.4.1 Social

Social aptitude is fundamental as it is a practice to interact with other individuals day by day. It is unquestionably an aptitude that must be produced in the early age for the children to make new companions and comprehension to other individuals' behaviors. Then again, autistic children are having an excruciating time here. They show inconveniences in identifying with individuals whereby there is impedance in peer communication and social relations (Virginia Department of Education, 2010). This disability may come about because of their shortcoming in relational abilities. In what manner would they be able to interact with others, on the off chance that it is a test for them to pass on their expressions? Henceforth, numerous individuals would decidedly concur that creating autistic kids' social aptitude would be an alternate necessity. Successful social aptitudes are pivotal to manufacture fruitful interactions in home and society (Stone, 2010).

2.4.2 Independence

As a kid ages, gradually and ceaselessly they are prepared to wind up independent, as they get more established they will be out in this present reality to run their everyday routines. Consequently, parents particularly will help their kids to separate what is great and what is terrible. Regardless, autistic kids however have impedance in everyday exercises. They couldn't comprehend what is going on in their surroundings in this way its troublesome for them to get included. What's more, their senses are joined and this will come about to absence of familiarity with dangers. Hence, it is vital for them to comprehend and be prepared to wind up independent as to make due later on. As they get more seasoned, there is a plausibility that their guardians would not be there any longer to care for them. By picking up the abilities needed for their day by day exercises, autistic kids will have the capacity to mobilize independently (Virginia Department of Education, 2010).

2.5 Learning Theories

Children with autism have an alternate route in learning and tolerating data that is different from typical well developed kids. In view of the deep rooted nature of autism that cause inconveniences in communication and social cooperation, together with restricted and monotonous conduct, various medications, methodologies and hypotheses have been directed to help these kids. The primary destinations of these speculations are to enhance the kid's communication and social conduct, alongside diminishing the rate of limited and monotonous conduct (American Psychiatric Association, 2000). There are different methodologies and medications connected in teaching autistic child. In any case, the fundamental methodologies are Applied Behavior Analysis (ABA), Social Communication, Emotional Regulation and Transactional Support (SCERTS) and Robotic Approach.

2.5.1 Applied Behavior Analysis (ABA)

ABA is the procedure, application, and appraisal of natural adjustments to create socially significant upgrade in human conduct (BACB, 2012). ABA methodology embodies the act of immediate perception, assessment, alongside functional investigation between the communications of environment and human conduct. Also, it adjusts encompassing occasions and exercises to make valuable and vital changes in kid's conduct, which incorporate their abnormal and dull schedule. ABA is the execution of instructing and motivator to the result of social ramifications' issues (Granpeesheh, 2009). ABA is examined as one of the best practice medications that was acknowledged its common sense, quality, and viability. On the other hand, this methodology may take long time to give come about and advance, as a solid ABA program incorporates perpetual individual training, supervision, family training and group meeting (BACB, 2012).

2.5.2 Communication

Communication is essentially the perfect approach to start and end everyday life routines. Whether you are at home doing errands or going to work amid the day or actually indulging social interaction with other individuals. Communication is exceedingly critical to maintain one's life, whether it’s verbal or nonverbal communication. Be that as it may, most kids with autism have an issue around there. They are experiencing issues in languages ability whereby it is hard for them to process what others are stating (NIDCD, 2010). Also, they have issue even in non-verbal communication like hand signals and facial expression. In this way parents and therapists couldn't consummately talk with autistic children as understanding the kid's expression is troublesome and the kid themselves couldn't express what they need. Therefore, it is essential to help these kids in creating their relational abilities by all methods conceivable. By upgrading languages, it can help in creating socialization and interactions of autistic children with other individuals (Lewis, 2011).

2.5.3 Social Communication, Emotional Regulation and Transactional Support (SCERTS)

SCERTS empowers expansive educational approach that gives an opportunity and succession of dynamic objectives by focusing on noteworthy, reasonable advancement inside every day schedules at school, home, and in the general public (Prizant, et al. 2003). The motivation behind SCERTS is to addition formative achievements, for example, social association, communication language and enthusiastic development. It additionally gives a blueprint to teachers and parents to choose intelligent and learning backings that are viable for their autistic kid. SCERTS advertises kid launches in regular communication, which characteristically concern viable and related aptitudes circumstances and diverse accomplices (Wilson, 2010).

2.5.4 Robotic Approaches

Robotic approach is a new method in educating autistic children, which uses sensors and other peripherals such as motors to communicate. The best proposed engagement for nurturing autistic children is to utilize robotic approach. This is due to the fact that robot are practically emotionless and they can give feedback according to the stimulus they receive from their exterior surroundings depending on the program that has been cultivated in the brain of the robot (Dautenhahn, et al., 2004). Plus, autistic kids usually have a hard time especially when it comes to focusing on other individuals facial expression and this is why the robot are deemed to be the best amongst all other option since it have no face at all. Since most of the autistic children shows strengths in solid thinking, memorization, and comprehending of nonverbal relationships and endeavors in abstract thinking, social perception, interaction, and attention (British Columbia, 2000).Therefore, with the aid of robots, autistic children are more enthusiastic and are able to mature more as their core strengths are being amended day by day.

2.6 Robotic Approach in teaching autistic children

The robotic intervention in nurturing autistic children has been very helpful in enhancing reading skills and generalizing knowledge for young pupils with autism (Michaud, et al., 2002). The sequence, progressive development is well defined and simple for therapists and parents to amend and keep track of the child's improvement. A rising comprehension of the robotic learning practice of autistic children is getting more attention from academic society. Autistic children go through their day by day activities by their weak senses that can be further enhance with the aid of robotics. It reduce the tension for them to rekindle what happens later, give a concise and clear path between actions, and aid them to be independent. The nonverbal signs shown to them can last a long time since they have a habit of repeating on every action they learnt (Michaud, et al., 2002). Thus, robotic

engagement has causes the evolution of education practices amongst autistic children.

2.7 Robotic Application for Autistic Children

Robotic technologies are a popular trend in advanced countries such as Japan and The United States of America. Nonetheless, it is getting the attention of developing countries as well. With the technology's uniqueness, interact ability and the robustness, daily events now seems to be simpler and yet entertaining to indulge with. Plus, robotic technology has already begun to penetrate the education market as well as forging an easier life path for those learning disabled children. Education is now considered more exciting with the aid of robotics. Children are gaining interest and are learning deeper with the utilization of robotic technology as the sensors and the response presented by the robots are now more eye-catching. For an autistic child, it is paramount to maintain their interest in learning, as they tend to easily distracted with other stimulus happening surrounding them. Thus, with the intervention of robotic technology devices like NXT or EVA3, they can pay more attention and enticed to learn and keep on utilizing it. Most autistic children respond well with the display that NXT offer and although technologies have its drawbacks at times, with NXT it will surely be easier for children with autism than those without (Stone, 2011). Furthermore, robotic devices can also function as a means of communication for autistic children. This will aid them in comprehending and nurturing their aptitudes as well as initiating or interacting with other individuals. Robotic devices provide a path to interact their necessity and emotions (Robins, et al.,2004).

2.8 Previous Related Work

There are variety of applications has been created to address this problem, which can be categorized according to the nature of the device.

2.8.1 Mobile Robotic Toys and Autism

Mobile robotic toys are basically a framework of intelligent processors and sensors attached together and covered with furry animal like cover to captivate the attention of those autistic children. It has the capability to interact back at the user's response towards it depending on how it is programmed by the developer of the robot. This have become an intriguing feat as it is less costly to create such a robot and it is also less time consuming in terms of programming the function as the processors are made from standard PIC18F4520 chip where it can compute simple instruction and give the appropriate response via the chip endings attached at the motherboard of the processors where the response will be manifested via motor rotation, sound emission and much more depending on the programmer's likings (Michaud, et al., 2002).

Figure 2.3: C-pac mobile robotic toys that are used to engage with autistic children (Michaud, et al., 2002)

The figure above is basically showing one of the various model of mobile robotic toys that are used to interact with autistic kids. This robot are mainly

specifying its functionality on nonverbal language so that the autistic kids can get the idea that the robot are trying to convey (Michaud, et al., 2002). This helps in terms of aiding their comprehension skills about their surroundings.

Figure 2.4: Cari 2 Bot is interacting with one of the autistic child (Michaud, et al., 2002)

The figure above is demonstrating one of the mobile robotic toys functionalities which are communicating with autistic children via gestures. This has many good implications as it teaches the children how to communicate with other individuals properly and at the same time improve their cognitive skills.

However, it also has its drawbacks, due to its simple processor, it cannot compute complex instruction and hence it can only attached with simple sensors which mean it have low level of accuracy in detecting stimulus around it and have a slow reaction time due to low processing power. Apart from that, the components in creating the robot are rigid and cannot be customized at will since most of its part are custom made and it contribute to its lack of versatility.

2.8.2 Human Robot Interaction Intervention Therapy Procedure for Initial Response of Autism Children with Humanoid Robot

Human robot interaction is mainly a therapy where a robot is used to convey an idea via special means toward its target users namely the autistic children. In this NAO robot is used to tackle that task since it’s already equipped with a set of sensors

in it. Those sensors are camera which is embedded in the robot's eyes and at the back of its head so that it can track the user's whereabouts. Apart from that, it is also equipped with sound sensors and speakers so that it can interact verbally though its communication abilities are still primitive compared to normal conversation. Not to mention, it also has several motor function at its joints so that it can propagate smoothly to captivate the audience eyes namely the autistic children.

Figure 2.5: NAO Robot (Shamsuddin, et al., 2012)

The above figure displays the built of NAO robot where it comprises of many peripherals as stated before. It can talk simple grammar such as asking names, reply simple questions and other simple conversation as it processing power limit its capabilities to simple interaction only. Plus, it can also sing some songs and dance since it have fluid motor joints and that make it a saving grace for the robot to gain the autistic children's attention. The most remarkable attributes of this robot it have face recognition function where it can recognize its users by taking the picture of its users face and store it in its local memory for future use (Shamsuddin, et al., 2012).

Figure 2.6: Interaction time between autistic child and Humanoid Robot NAO (Shamsuddin, et al., 2012)

The figure above showing the recordings on how the Humanoid Robot NAO interacts with autistic children and from the result, they can measure the responsiveness level of a particular autistic child. This is pretty convenient since the robot is simple to utilize and its programming user interface is easily understandable and anyone can operate it with ease. Plus, the robot have some intriguing function that can maintain the autistic child interest into communication such as speaking, dancing and singing (Shamsuddin, et al., 2012).

The only setback is that the robot is already fitted that way and it is not customizable and thus it gives us the notion that it lacks versatility. Furthermore, it was made for simple functionalities and basically it restrict us from exploring more into the depth of an autistic children's mind and this gives a big letdown as we can't really use robotic technologies to its full potential.

2.8.3 LEGO Therapy for Autistic Children

LEGO Therapy is basically a treatment for learning disabled group of children and since autistic children also falls under the same group, which is why this therapy is perfectly suitable for autistic children. The LEGO Therapy itself comprises of various kind of numerous LEGO bricks where it is put together at the center of a table where all autistic children will stay together and try to collaborate with each other building something out from the bricks provided earlier (Owens, et al., 2008). They usually will be supervised by assigned therapists where they will help guide all the autistic children in the therapy session to achieve their common goals which is to enhance their teamwork skills so in a way they can also improve their communication and socialization aptitudes. Through this therapy, also it can nurture these children about building skills which promotes their cognitive skills and boost their creativity (Owens, et al., 2008).

Figure 2.7: LEGO Therapy session is on the run (Owens, et al., 2008)

The figure above shows how the LEGO Therapy is conducted where the therapists will be assigned one autistic child each and they will guide the children step by step throughout the session. They will also encourage the kids to interact with their own kin so that all of these children can boost their self confidence in talking with other people. This is great since it helps them fix their weaknesses and yet boost up their passive skills such as creativity and their logical reasoning.

However, this therapy still involves the intervention of human. Since they're a human in it, surely there will be facial expression. The autistic children particularly have always had a hard time when it comes to dealing with this kind of circumstances due to the fact that their perception skill is weak and they cannot comprehend what other people are trying to relay especially when that other individual are using nonverbal languages such as facial expression and gestures. Plus, as a human we also have our limit and human tend to get enraged easily due to their behavior and this is why this therapy sometimes has its hiccups.

2.8.4 Specialisterne

Thorkil Sonne established Specialisterne as social innovator company using the traits of people with Autism Spectrum Disorder (Wareham, 2008). He obtained the motivation when his own son was diagnosed with ASD when he was 3. Thorkil Sonne have a keen interest in IT and after 15 years' worth of involvement, he started to invest in using LEGO Mindstorm in communicating with those who were suffering from ASD. This also comes from the inspiration when he realizes that his autistic son, even though lack communicational abilities, his son possesses superb visual memory as his son can memorize almost an entire picture with just a glimpse. Even today, Specialisterne strive to educate people with ASD so that they can stand on par with other people around the globe.

2.9 Summary

The reason autistic children cannot digest knowledge well in their education environment can be categorized into internal and external factors. Besides, numerous researches were carried out on existing system to analyze the teaching method of the devices. The research on existing system is summarized in Table 1 below.

Table 2.1: Summary of Existing Robotic Applications for Education

No.	Existing Device	Advantages	Disadvantages	Physical Customizability	Programmability	Learning Disabilty
1	Mobile Robotic Toys (Michaud, et al., 2002)	It teaches how to communicate properly	Lack processing power and can only execute simple functions	No	Yes	ASD
2	Human Robot Interaction NAO Robot (Shamsuddin, et al., 2012)	Easy to use and easy to understand and program	The design is rigid and it is hard to customize it according to others likings	No	Yes	ASD
3	LEGO Therapy (Owens, et al., 2008)	It nurtures teamwork and boost creativity as well	The intervention of human make the autistic children hard to progress further	Yes	No	ASD
4	Small Humanoid Robotic Assistant (Robins, et al., 2005)	It teaches autistic children how to socialize	It is hard to customize since the part of the robot is expensive	No	Yes	ASD
5	Robots for Kids (Druin, 2000)	Provides very interactive environment of learning	The cost of maintaining it is expensive	No	Yes	For all types of Learning Disability
6	Robots for Babies (Behrmann, 1984)	Provides early education for babies and can be used to diagnose mental related problem among babies	The cost of acquiring it is expensive and the programming is not user friendly.	No	Yes	For all types of Learning Disability

From the literature cited here, the research proposed a robotic application called AUTISTHERAPIBOT that will adapt the ability to teach the basic foundation of knowledge namely the ability to recognize colors. It will detect various kinds of colors and sort it out accordingly and based on the autistic children's response it can also perform some action to captivate the children attention and gain their interest in learning something new. The target users for AUTISTHERAPIBOT are the autistic children who have the inability to learn via their perception skills due to the difference in their brain structure.

CHAPTER 3: METHODOLOGY

3.1 Introduction

In this chapter, the methodology being used is going to be discussed and further elaborated. There are two main compartments of the methodologies, which are the research methodology and the system development life cycle (SDLC). The SDLC methodology that has been chosen is Rapid Application Development (RAD) methodology followed by a qualitative research methodology for research and deeper analysis.

3.2 Development Methodology

The Rapid Application Development (RAD) methodology has been amended for the development methodology of this application. This particular software development life cycle methodology consists of a short and swift planning phase to focus on the prototyping phase. Upon reaching the completion of the requirement procurement phase, which comprises of the planning and analysis process, the prototyping phase takes place, followed by the testing and launching or deployment phase. The RAD methodology is illustrated in Figure 3.1 below.

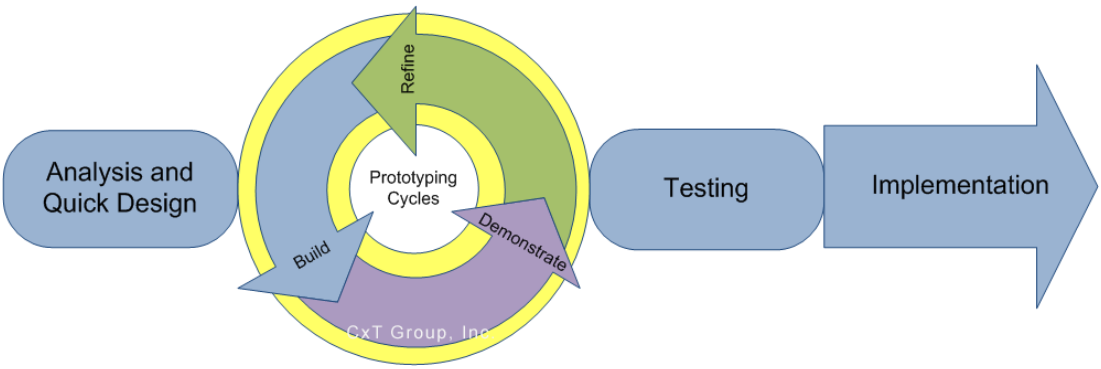


Figure 3.1: The Rapid Application Development Model

In RAD model, the development is done simultaneously for prototype and are intertwined or joined to create the finished product for faster product delivery. Since there is neither proper documentation nor detailed pre planning, it makes it easier and swifter to integrate the modification within the development process. The activities of the project can be classified into 4 main phases which is requirement gathering, prototyping, testing and deployment of the application or system.

The reason RAD model is chosen is due to the fact that the project is of medium size and due to time constraint, the project need to be done in a swiftly manner and this model is the most suitable because several phases of the project can be executed simultaneously.

3.2.1 Requirement Planning

The submission of the project title with the endorsement of supervisor took place in the second week of FYP 1. This is ensued by a proper planning of schedule done by creating a Gantt chart and key milestones. The reason of these deliverables are to ensure time is utilized as efficiently as possible and also to track where are the project is heading so that the project can stay true to its path towards its goals. The Gantt chart and key milestone is shown in Table 3.1 and Table 3.2 respectively below.

Table 3.1: Gantt Chart for FYP 1 and FYP 2

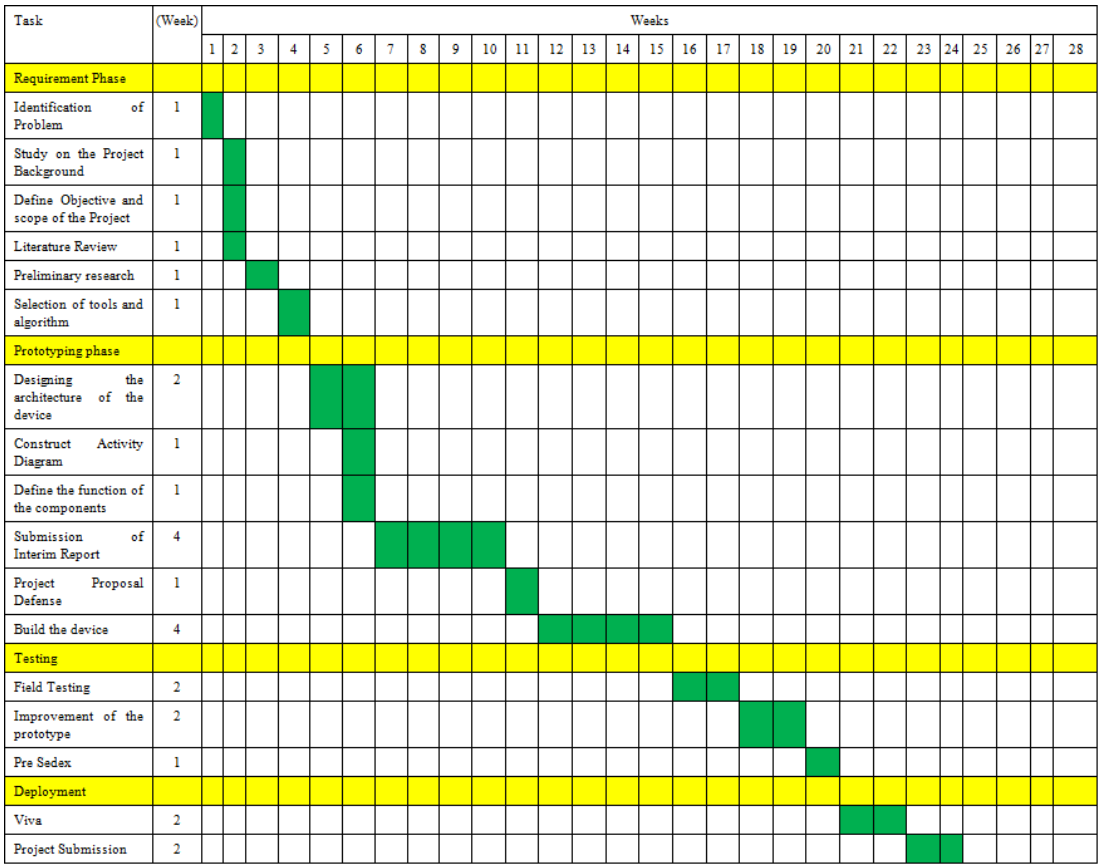


Table 2.2: Key Milestone for FYP 1

Milestone		Week
Selection of Project Title	0%	2
Interim Report	40%	12
Proposal Defense	50%	14

During this phase all the requirements will be tracked down. Preliminary research was done by visiting a special school in Batu Gajah. The objective of the visit is to procure data and analyze on the behavior of autistic children and knowing what their aptitudes are and later categorize them into two different classes which are their strengths and weaknesses. From this, the project can enter the stage where best possible method can be applied to assist these children in their process of learning. The method that is used for data collection is via interview, and questionnaire.

Analysis is being done critically via analyzing the journals and other reliable sources for current existing system. The results of the surveys were also kept private

from public knowledge. This analysis on the literature review is useful to enable comparative study on the existing mechanism of teaching autistic children as compared to the new autistic therapy teaching device.

3.2.2 Prototyping Phase

The initial prototyping stage starts with a design stage, where the assembly of hardware, software and user interface is manufactured. The sensors used are tracked, and the system architecture of the autistic therapist assistant robot is illustrated. The activity diagram shows the flow or function of an activity to another in a system. AUTISTHERAPIBOT is designed and the following peripherals namely the sensors are identified.

The prototype is built using LEGO Mindstorm NXT which is a programmable robot set. The building of this robot incorporate constructing a tangible android robot using LEGO Mindstorm NXT, ensued by programming the functionality of the robot using the NXT software. The program is transferred later into the brick of NXT which is the brain or the CPU of the robot either using Bluetooth or a USB cable.

3.2.3 Testing Phase

In this stage, a field test has been conducted in *Sekolah Kebangsaan Sultan Yusoff* located in Batu Gajah, Perak. Most probably in the early weeks of FYP2, usability testing will be initiated on the autistic children to assess the device via testing it on the kids and the therapists. The therapist will initiate the robotic function and the children will try to imitate what the therapists are doing by controlling their own set of robot. The evaluation will be recorded in terms of interviews and also observation. It also provides a direct feedback and instant insight on the drawbacks and the enhancement that can be applied to upgrade the device.

3.2.4 Deployment Phase

This is the final phase where after going through the usability testing and the appropriate enhancement is done, based on the insight received, AUTISTHERAPIBOT will be ready to be installed and utilized by both the autistic children and their respective therapists.

3.3 Research Methodology

The research methodology that has been amended is the qualitative research method which is very effective for information gathering purposes. Comprehending the reason for each human action can be researched via qualitative method as it will seep through the very root of the cause for any causal effect that happen afterward.

3.3.1 Proposed Framework

The architecture of the system application is developed after initiating research on the autistic children. These system focuses on aiding the therapists to teach some valuable knowledge to their respective autistic students which in a sense help them boost their comprehension in their process of learning. Therefore, the simplicity of the front end of the system is given utmost priority during the development of the robot architecture so both the therapists and the autistic children can comprehend how to utilize the robot properly. The flow of the system is illustrated in the activity diagram in Figure 3.2 below.

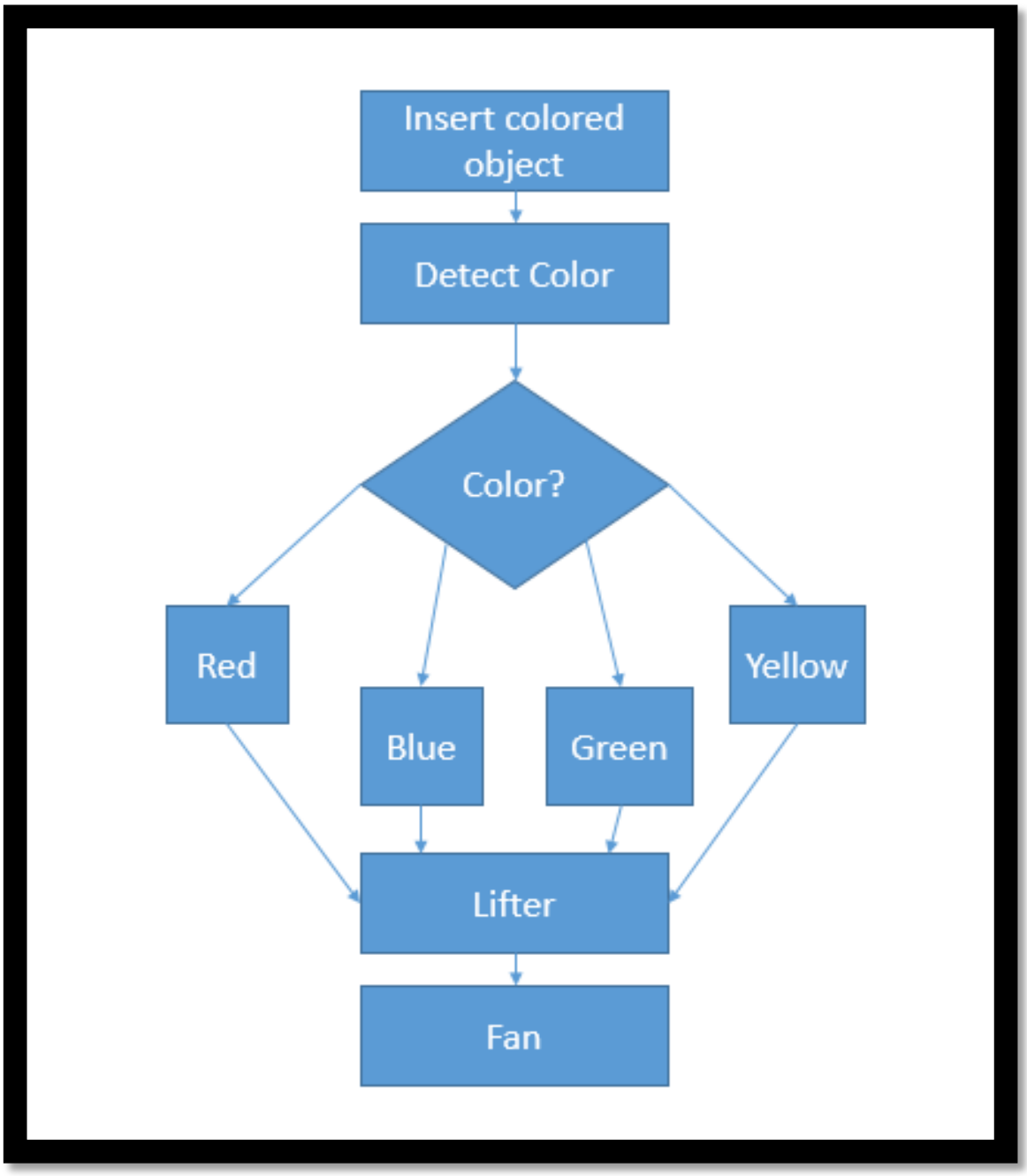


Figure 3.2: The process flow of AUTISTHERAPIBOT

The general architecture of the robot is illustrated in Figure 3.3 below.

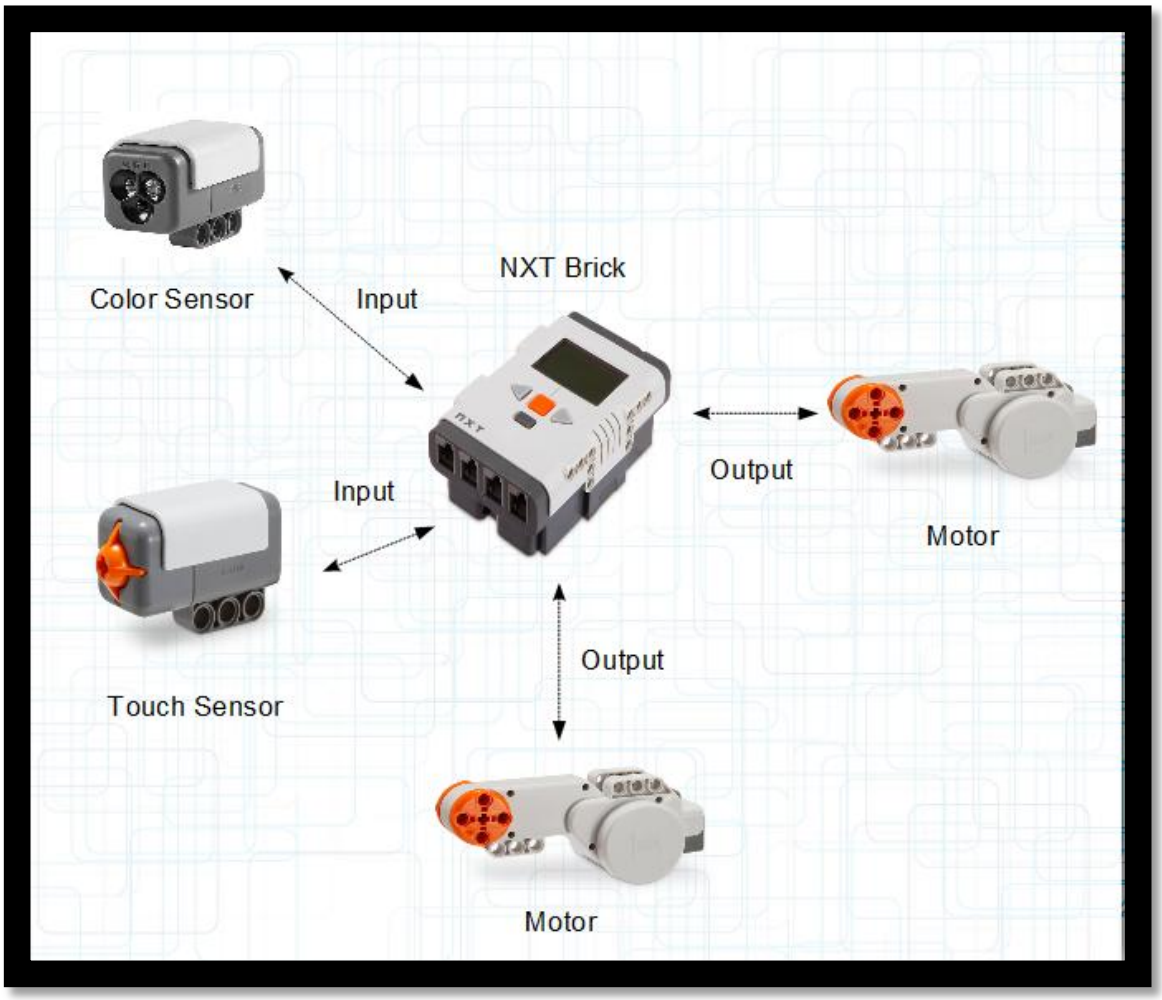


Figure 3.3: General Architecture of AUTISTHERAPIBOT

The color sensor and touch sensor is responsible to sense input from the therapist and even the autistic children themselves. Once the robot receive the input, the signal will be sent to the LEGO Mindstorm NXT brick, which compute the input and starts sending response signal to the motor which later determine whether the particular is going to be sort out based on its color or otherwise. After the completion of the sorting, the motor will press the touch sensor indicating it have finish doing its task and prepares itself for another incoming object.

3.3.2 Tools

The LEGO Mindstorm provides robotic tool kit that has been commercialized. This programmable set provides a uniform platform to be utilized which enables future enhancement over this particular robot. It provides a programmable set with sensors and hardware peripherals which can be further purchased independently when needed. The main components of LEGO Mindstorm NXT are shown in Table 3.3. Most of these tools are proven successful as stated by Wareham (2008) where Thorkill Sonne initiated the use of LEGO Mindstorm in Specialisterne to educate those with ASD.

Table 3.3: Description of LEGO Mindstorm NXT components

Components	Description
LEGO Mindstorm NXT Brick 	• The brain of LEGO NXT • Control other parts as per programmed • The program can be transferred via USB cable or Bluetooth
LEGO Mindstorm Motor 	• Enables propagation • Required to build a mobile robot • Enables gearing • AUTISTHERAPIBOT uses motor to sort the coloured object
LEGO Mindstorm NXT Colour Sensor 	• Allows colour detection • AUTISTHERAPIBOT uses colour sensor to distinguish colour
LEGO Mindsotrm NXT Touch Sensor 	• Allows touch detection • AUTISTHERAPIBOT uses touch sensor to stop its operation
LEGO Mindstorm NXT Building Parts 	• Building block of the robot • Used to build the AUTISTHERAPIBOT

3.4 Data Gatherings

This approach is used to acquire data related to the study. Several methods were used for the procurement of data, which includes visits to the special school for children with learning disability. Information is gathered in order to be further analyzed to come up with the outcome of the research. For instance, interviews have been exercised to procure data. The interviews questionnaire are attached in the appendix section.

3.4.1 Pilot Study at Sekolah Kebangsaan Sultan Yussof

Sekolah Kebangsaan Sultan Yussof was chosen for the pilot study due to the logistical factor. The location of this special school is close to UTP where about, which is around 15 km in distance.

Sekolah Kebangsaan Sultan Yussof was established in 1907 as an English private school by J.H.D. Oliveire and it is limited only to those of noble blood and English people. Soon after the World War 2 had erupted, after the colonization of the Japanese, the school was taken over by the locals in the year 1947, the school thrives to be an outstanding school throughout the century till today but in the year 2003, the school received special funding from Malaysian Ministry of Education to set up a special school for children with learning disabilities so that they also can be a good human capital for the nation. The special school was set up by Che Rosli Bin Haji Ibrahim in the same year also. The average number of pupils since it was established to the present is in the range of 20 to 40 children and it is currently at its optimal capacity of 35 people.

All observation and management of welfare for the school is monitored by 5 committee members consisting of 5 women as illustrated in Figure 3.4 below. The committee ensures the process of teaching to those children with learning disability runs smoothly and will try as best as they could to give them proper knowledge to survive in this world. They are also being helped by well-trained therapists but they are not teaching there permanently as they always switch their shifts according to their duty rosters.

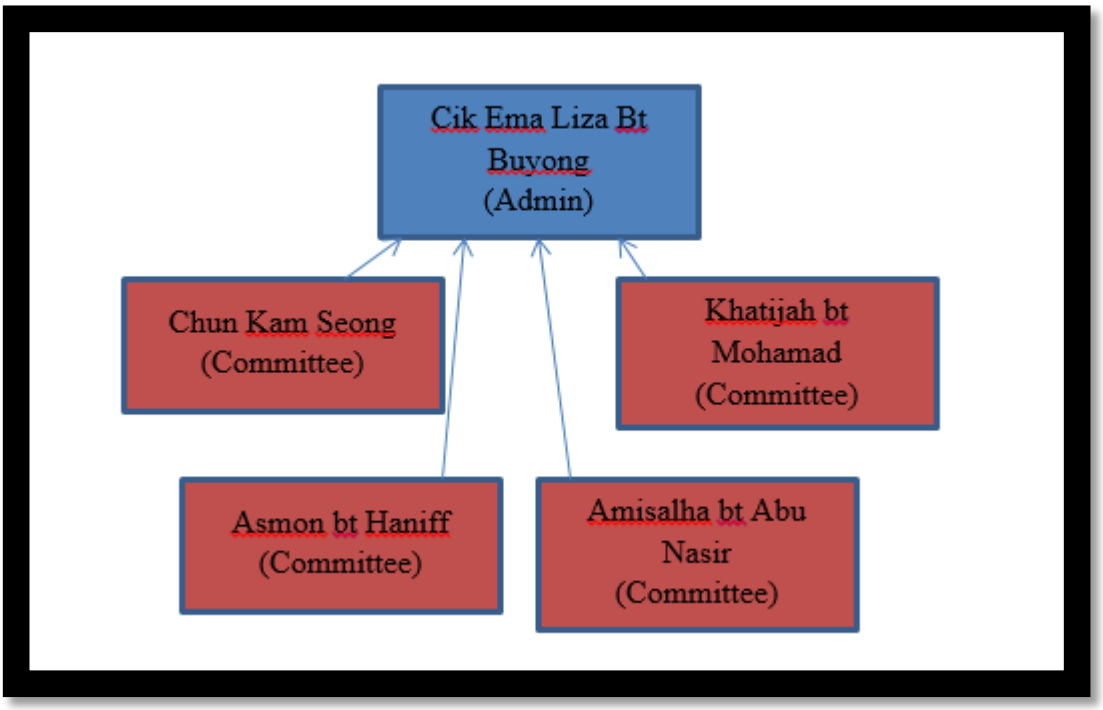


Figure 3.4: Committee members of the special school in SK Sultan Yussof

The special school was built by the Federal Government on the school's and is situated in the residential area of Kampung Sungai Terap. The school was built with one store room and 3 classroom where the store room stores the peripherals to aid the children's process of learning while the other 3 classrooms is for separate learning disability disorder.

3.4.2 Data Analysis

Interviewing the therapists in the special school enables information procurement on the path towards efficient learning methodology for these learning disabled children. Interviewing is one of the commonly used strategy as a source of data collection when it comes to human scientific and behavior research since it plots every traits one by one thoroughly so that we can see the clear picture of what is going on and what contributes to the manifestation of that particular scenario or event. Therefore, this method is chosen and used to analyze the problems faced by the autistic children and their respective therapists followed by interpretation of the information obtained.

In order to obtain the pattern or behavior of how the autistic children learns, the data analysis stage takes into place. This is carried out to decipher the gathered data systematically. The factors affecting the behavior are also found out.

CHAPTER 4: RESULTS AND DISCUSSION

4.1 Introduction

In this particular chapter, further discussion on the result of the research is done, including interviews and observations. A visit to Sekolah Kebangsaan Sultan Yussof was carried out on 3rd July 2014 to gather initial data for the basis of the project. The school have a sub special school specifically for students with learning disabilities. There were around 40 students there and 10 of them were those with ASD. The special school were handled by 10 experienced therapists that work on shift. There were usually 6 therapists working daily catering the students with learning disabilities. The data gathering was basically procured via observations and some interviews.

4.2 Qualitative Result

A visit to the special school, '*Sekolah Kebangsaan Sultan Yussof*', as shown in Figure 4.1 below was conducted on 3rd July 2014.

Figure 4.1: The special school in Batu Gajah, Perak

The main intent of the visit was to acquire data on the current way of teaching the autistic children or the way the therapists carry out their therapy towards their respective students and the hiccups faced by them when their pupils cannot comprehend what they are trying to teach. The therapists were interviewed based on the same set of questions. There were 6 respondents in the special school comprising of all female therapists. The summary of each autistic child are shown in Table 4.1 below.

Table 4.1: Summary of autistic children at Sekolah Kebangsaan Sultan Yussof

Students	Age	Gender	Type of ASD
Student 1	6	Female	Asperger Syndrome
Student 2	7	Male	Asperger Syndrome
Student 3	7	Male	Asperger Syndrome
Student 4	8	Male	Asperger Syndrome
Student 5	9	Male	Asperger Syndrome
Student 6	11	Male	Asperger Syndrome
Student 7	10	Male	Asperger Syndrome
Student 8	9	Male	Asperger Syndrome
Student 9	8	Male	Asperger Syndrome
Student 10	8	Male	Asperger Syndrome

4.2.1 Structured interview

A structured interview was conducted on the therapists to find out on how they teach their respective autistic pupils namely the autistic children. The initial interview was carried out on 6 therapists of the special school of Sekolah

Kebangsaan Sultan Yussof. They were chosen as the interviewee due to the fact that they will be the one to use the AUTISTHERAPIBOT. Learning their behavior of teaching helps to add helpful features to AUTISTHERAPIBOT. The objective of the interview is to study the problem that are being faced by both the autism therapists and the autistic children as they both cannot get on the same page in terms of disseminating and grasping of the knowledge.

The 6 respondents were first asked about what they know about autism since they have been dealing with autistic children for quite some time. Most of them i.e. 4 believed that autism is leaning more towards the different way of thinking or basically said a different mentality if compared to other normal kids while the other 2 convinced themselves that it is due to the fact that their brain structure is different that later cause their mental disorder which is ASD. It can be shown in Figure 4.2 below.

Question 1	Different Mentality	Brain Structure Disorder
What is Autism?	4	2

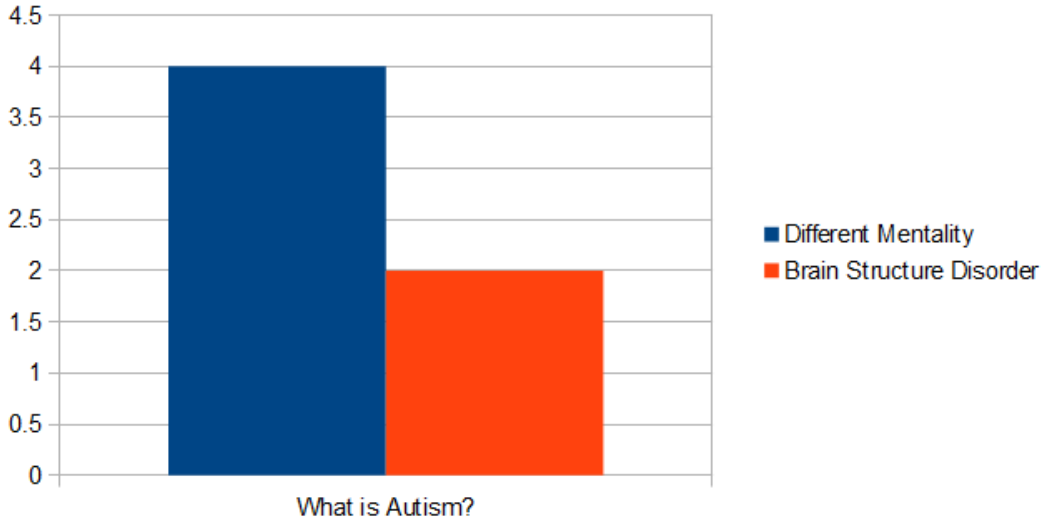


Figure 4.2: The Definition for Autism

The understanding of autism is paramount for the project so that the identification to the root of the problem can be identified. For this case, the impairment in the brain structure is what leads to the definition of autism since brain

structure plays a crucial role in the way we behave and how we coordinate our cognitive skills and also the running processes in the subconscious mind. Most of the therapists believed that autism primarily means the difference in mentality and this is quite irrelevant since mentality is heavily influenced by external factor such as upbringing by their parents and also peer effect where people surrounding them influence the way they think. This contradicts with the statement of Millar (2002), mentioning that 1 in every 68 born baby throughout the globe will show the symptoms towards autism by the age of 3 due to some defect in brain structure during brain development in child growth in the frontal cortex. Therefore, the children are most likely having difficulties in receiving knowledge from the therapists since the therapists still did not understand the full concept of autistic syndrome disorder.

The following questions related to who gives the best result at teaching these autistic children. As Figure 4.3 shows, therapists are better compared to robot.

Question 2	Therapist	Robot
Who is better at teaching?	5	1

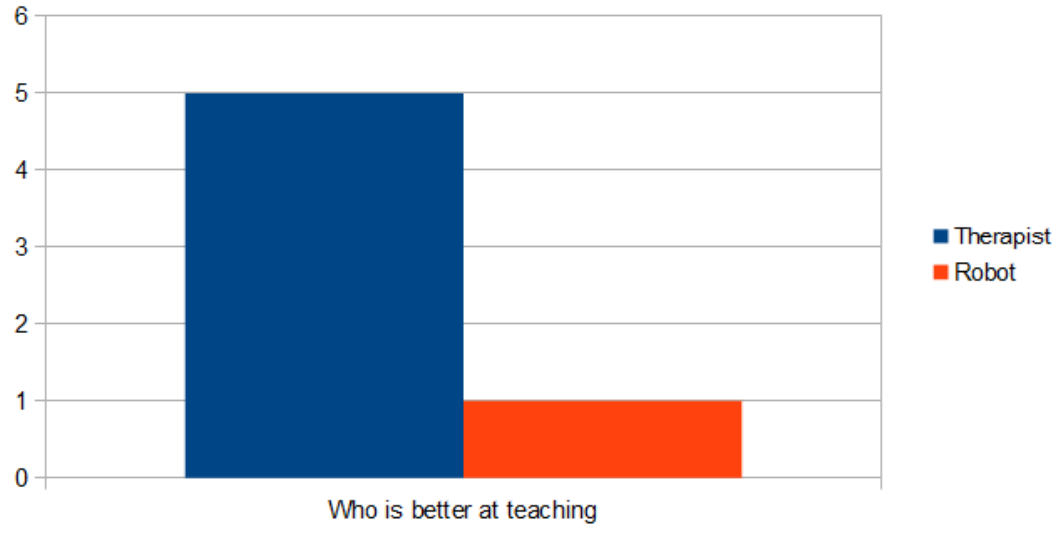


Figure 4.3: The effectiveness of teaching between a human therapist and a robot

Most of the therapists believed that the therapist are doing the better job if compared to the robot due to the fact that human have feelings and in a sense they teach the autistic children with compassion and they think through that, they can

reach the children's senses and make them get the message. Well, this is true since robot is emotionless and they are just static in monotonous in delivering ideas to the children. However, human have their own limitations. In this case, human therapist tend to get enraged easily due to the fact it takes an arduously long of time to convey an idea to an autistic children as stated by Michaud (2002) where he mentioned that 1 in every 5 autistic therapists around the globe tend to give in into rage since they don't have enough patience and tolerance to teach the autistic children and that is why in this case robots play a better role since as stated by Michaud (2002), robot can perform better at delivering their task since they won't get influenced by emotions because they don't have any in the first place but for this project, it will focus more on robot-therapist collaboration rather than substitution of the therapists.

The following questions involved in what the therapist think about LEGO NXT whether they think it will be a great help or a hindrance. As shown by Figure 4.4 below, it obviously shows that it will indeed offer great aid for them.

Question 3	Yes	No
Do you think LEGO NXT can help?	5	1

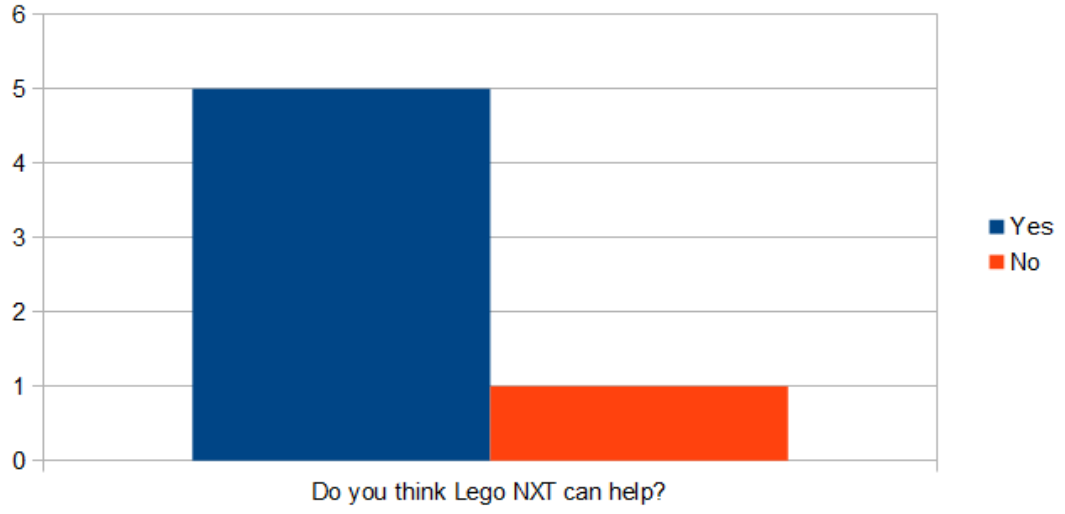


Figure 4.4: LEGO NXT Aiding Capabilities

LEGO NXT offers great help to the therapists since it is a programmable and customizable robotic kit so in a way they can modify the robot at will in order to assist them delivering knowledge more efficiently. This complies with Robins (2004)

where he stated that robot with the capabilities of customization will bring a great benevolence to the autistic children since the autism varies on individuals as stated by British Columbia (2000) where they mentioned even though autism have common characteristics, they still demonstrate unique attribute depending on one particular individuality. However, there is one therapist rejecting the idea due to the fact that it may impose danger to the children may be due to her worry about the potential of hazardous material used by LEGO in manufacturing their products. They don't have to worry about it since the product LEGO are producing is practically safe as mentioned by Owens (2008) where he stated that most of LEGO products are ergonomically safe for children.

The below question is about what is the element that can capture the autistic children attention and yet maintain their interest at the same time. From Figure 4.5 below, we can clearly see that there's a tie in opinion whether inanimate object or robot can give their best at gaining and maintaining the interest of an autistic children.

Question 4	Inanimate object	Robot
What can maintain their interest?	3	3

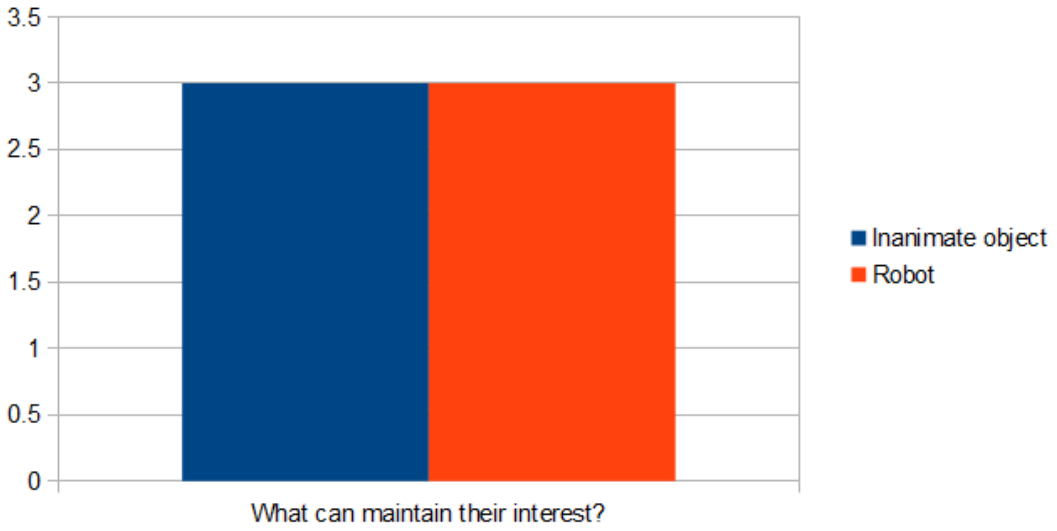


Figure 4.5: The Ability of Gaining and Maintaining The Autistic Children Interest

Robot as stated by Michaud (2002) and Robins (2004), they are good at the task of delivering ideas to the autistic children since they are not influenced by

emotion and yet at the same time inanimate object such as soft toys or a ball also could give the same impact as stated by Lord (1994) where he mentioned that inanimate object can act as a good catalyst for autistic children to venture into their own realms as they are imaginative in nature. So, in essence both can play a vital role in disseminating knowledge to the autistic children.

The following question is about whether robot can give positive impact on autism education or otherwise. From Figure 4.6, we can see that the therapist could see the big potential of robotic technology that may influence the autistic children positively.

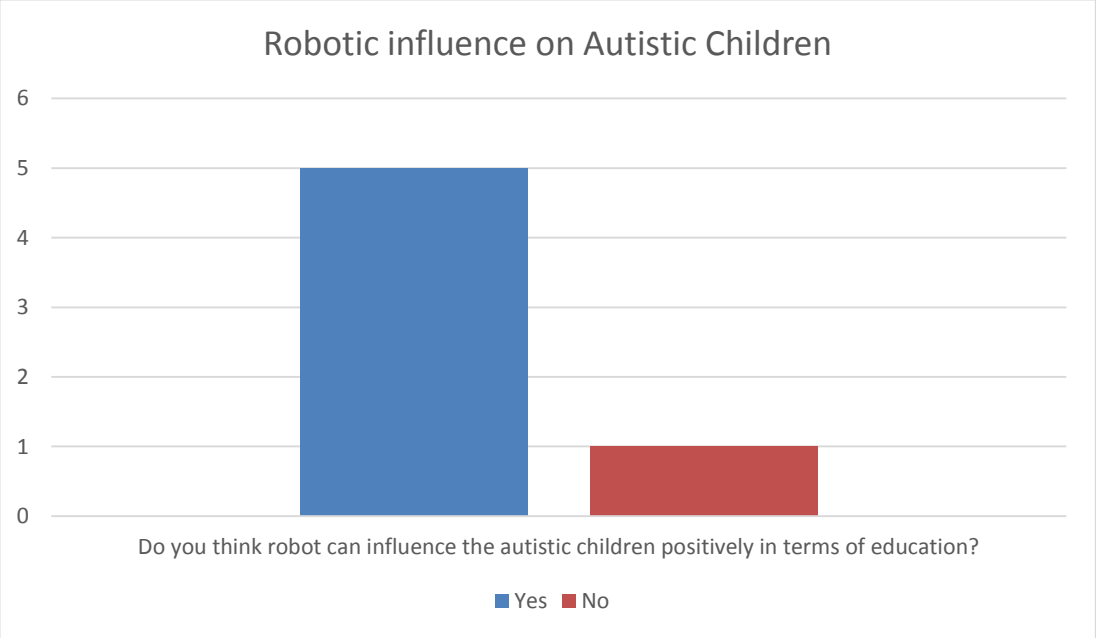


Figure 4.6: The potential of robotic technology on autistic children

Robotic technology can be diversified into many areas and education is no exception to this matter. Robot can be totally useful when it comes to aiding those with learning disability namely those with ASD. The above result complies with Lord (1994) where he stated that interactive peripherals such as robot hold massive potential in building good attributes among those with ASD.

The below question is about whether color can play an important role in educating knowledge and complement the ASD children's weaknesses. From Figure 4.7 below, we can see that the therapists have high hopes with the usage of colors

because they themselves aware that autistic children have keen interest on color and that alone could be a path to communicate with their mind.

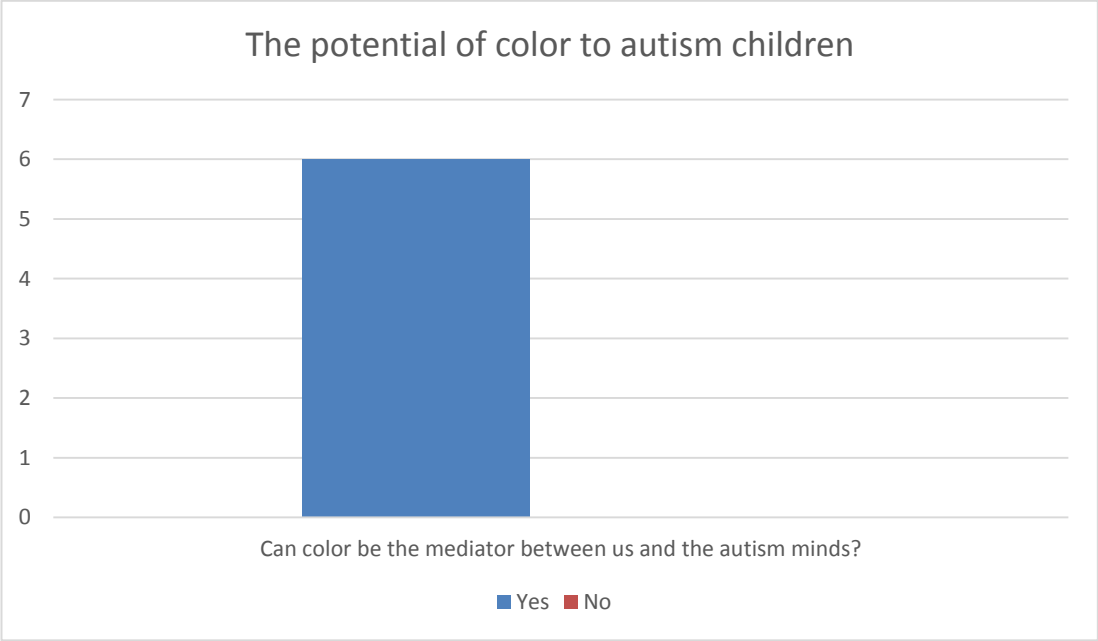


Figure 4.7: The potential of color to influence the attributes of the autism

Color could be one of the most feasible and plausible path in order for us to understand and communicate with the minds of those with autism since they have poor cognitive functions but a good sensory senses and it opens a path to exploit their strength to complement their weaknesses. This complies with Robins (2004) and Owens (2008) where they mentioned that color can play as an integral part in building the autistic children communicational skills.

4.2.2 Observation and Results

Observation is done mainly on the autistic children behavior and the location of the infrastructure of the special school. Based on the observation, the school consists of 3 classrooms and one store room which consist of their learning aid peripherals. The below Figure 4.8 will show one of the autistic children observed.

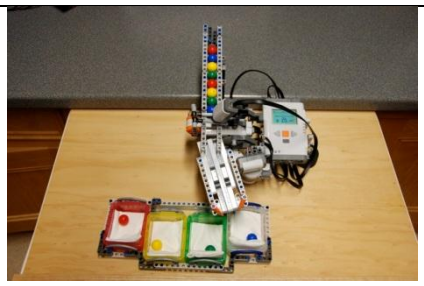
Figure 4.8: One of the autistic children observed

Based on the observation done to the autistic children, they seem to have unique behavior varies from individual. They are some of them who will only focus on their favorite TV cartoons while there are also one of them who were entranced by the rotation of the fan and they are even one of them who are restless where he love to walk and talk to himself in an agile manner until he fell exhausted. Thus, this shows the difficulty of the therapists to cater all their different attributes and this is why AUTISTHERAPIBOT will attack on their common characteristics to see whether they will accept it successfully or vice versa.

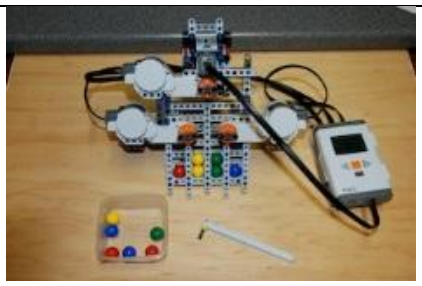
4.3 Prototype Design

AUTISTHERAPIBOT has been developed in several designs. This is performed to analyze the best robotic model to tackle this conundrum for the therapists and the autistic children. The objective of this prototype is to tackle the problems faced by the therapists and their respective autistic students by providing interactive color learning instead of traditional method such as color card, repetitive instruction and other technique that have low efficiency rate. The prototype has to be equipped with an object canal, where it enables the therapist or even the autistic kid

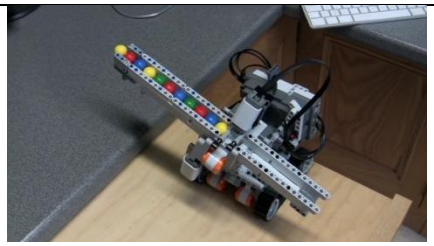
to insert colored object in it. This is then followed by a color sensor, determining the color of the object. If red is detected, the object will be placed in the red colored tray and it will also do the same for the other 3 different colors. Next a touch sensor will be acting as the trigger button to start or stop the operation. The potential benefit of utilizing this robot is that the therapists can provide more interactive and engaging therapy with their respective autistic students. The potential models of AUTISTHERAPIBOT are shown in Figure 4.9 below.



Design 1



Design 2



Design 3

Design 4

Figure 4.9: Potential Designs of AUTISTHERAPIBOT

Each design has its advantages and flaws as tabulated in Table 4.2 below.

Table 4.2: Advantages and Disadvantages of Potential AUTISTHERAPIBOT designs

Design	Advantages	Disadvantages
1	● Small in size ● Less space usage	● Not movable
2	● Sturdy	● Not movable ● Too much motor usage
3	● Small in size ● Less space usage	● Can distract others due to its movement ● Inability to keep the object
4	● More Interactive	● Too complex ● Fragile

Based on the table, design 1 is the most suitable design for AUTISTHERAPIBOT. This is due to the fact that one of the important features of AUTISTHERAPIBOT is the ability to keep the colored object in place so that the autistic children could grasp what it is trying to convey. Therefore, a design that keeps the colored object without sorting it out is unsuitable because it defeats the purpose of teaching about colors to the autistic children.

Besides, less space consumption plays a vital role when it comes to teaching the children about colors since it will be waste of space if we utilized a lot of space but just for single functionality. Therefore, a space consuming robot will hinder the children since the classroom area is not big enough for a big robot to fit in. The design is further shown in Figure 4.10 below.

The AUTISTHERAPIBOT are consisted of 3 components which are the color sorter, the lifter and the fan. Many components and sensors such as sound, color and touch sensors are used in the development of this prototype. Basically the children will observe the color sorting from the color sorter and then they can maneuver the lifter in order to understand whether the children understand what the color sorter are trying to teach and lastly the fan where it is a bonus feature that prolongs the interest of the children in using the robots. The objective of color sorter is to act as 'human therapy' to teach student to recognize and sort 4 types of colors endlessly. The colors are blue, yellow, green and red. The objective of the lifter is to test the understanding of the students based from the teachings of color sorter. Lastly, the objective of the fan is to motivate and encourage the student to speak up and also prolonging their focus in the usage of this robotic application.

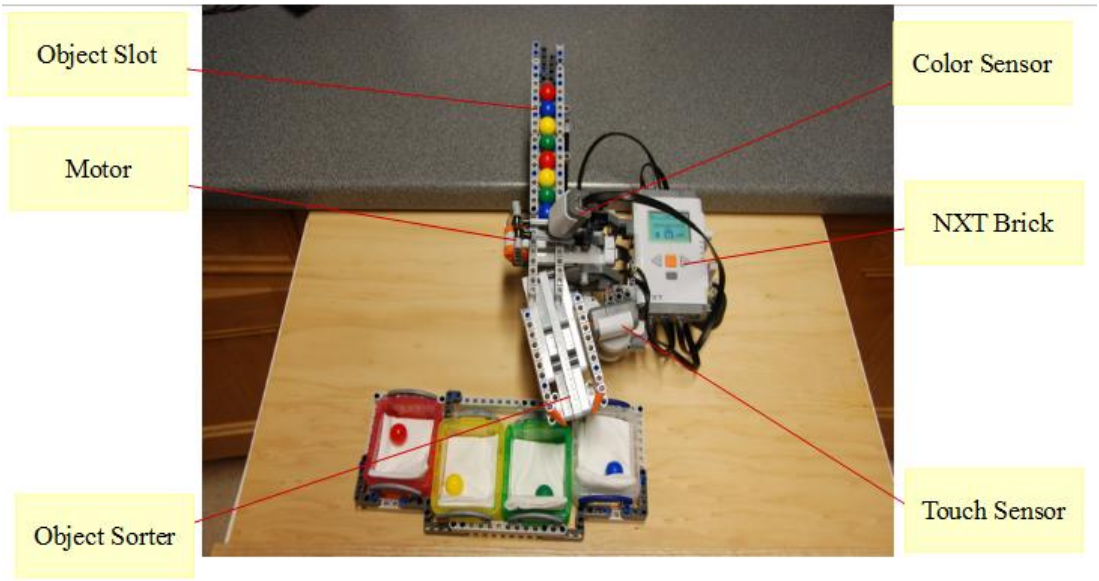


Figure 4.10: The overall view of AUTISTHERAPIBOT (Color Sorter)

Beside the color sorter, there are two more robots that made up the AUTISTHERAPIBOT robotic application. The two are the lifter and the fan. These two robot are created for the sole purpose which is to make the robotic application more interactive. The two robot can be viewed in the figure below.

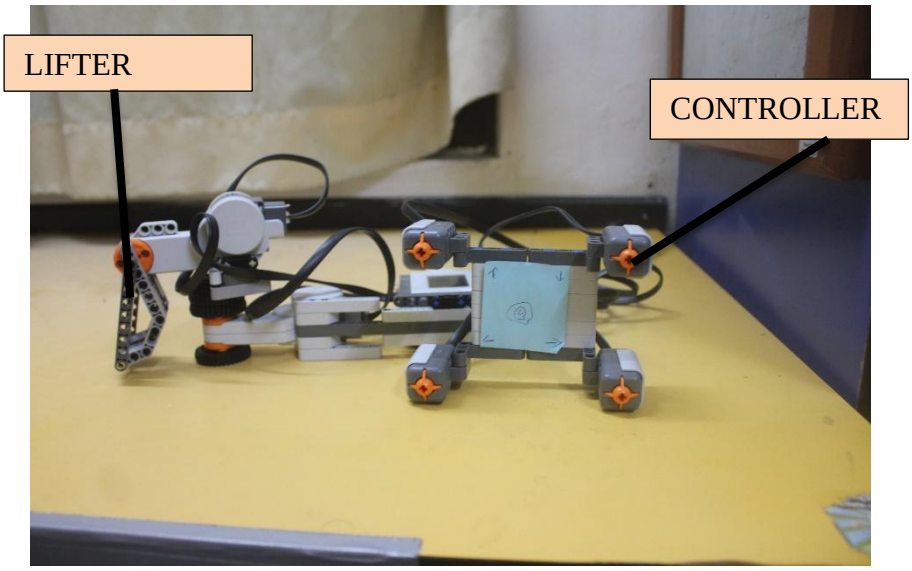


Figure 4.11: The overall view of AUTISTHERAPIBOT (The Lifter)

The second robot which is the lifter as seen in the figure above is basically a robot where the autistic children can control on their own to see whether they understand the teaching that have been taught by the first robot which is the color sorter. The robot consisted of two parts which are the lifter and the controller which are made up of four touch sensor signifying the four basic command such as moving left, right, upward and downward. This robot improves in terms of interactivity and also improve the child hand-eye coordination.

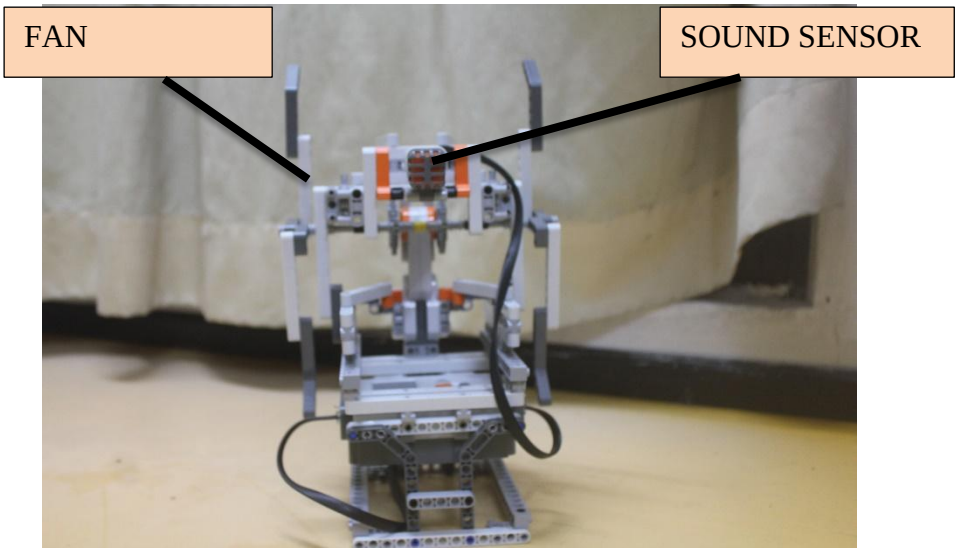


Figure 4.12: The overall view of AUTISTHERAPIBOT (The Fan)

Lastly, the third robot which is the fan is basically to incite the children's interest in participating with the usage of AUTISTHERAPIBOT. The primary purpose of this robot is to award the children if the children perform the color sorting with the second robot correctly since autistic children are easily captivated when it

comes to watching some movement. In this particular case, they love to watch a moving fan and that is why this leads to the creation of the third robot. This robot also indirectly helps the children in communication since the robot require a certain degree of sound volume in order for the fan to operate. The robot consisted of a motor which control the fan and a sound sensor where it detect incoming sound to determine whether the sound is adequate enough to propagate the fan.

4.4.1 Testing Phase

In this particular phase, the testing of the prototype have been done. This is to make sure the prototype could be programmed to acquire optimization. The testing was more towards usability testing since the test mainly checks on the effectiveness of the design and function of the robot in conveying ideas towards autistic children.

The test was carried out at Sekolah Kebangsaan Sultan Yussof in Batu Gajah where 5 candidates were chosen in order to accomplish the goal of the test which were to ensure that AUTISTHERAPIBOT accomplishes the project objectives which were to aid and educate the children via color sorting technique and the adaptability of the robot in the targeted environment.

All the 5 candidates have difficulties in recognizing colors and some of them knows some of the colors but they tend to get confused which color was which. The test was divided into two session where the first one was using the traditional method while the second one by using AUTISTHERAPIBOT. The test can be seen in the figure below.

Figure 4.13: The colored cards made from egg tray that are used in the special school

Figure 4.14: The AUTISTHERAPIBOT method

From the two figure above, we can see that the traditional method was utilizing the colored cardboard in order to relay information about colors to the kids while in the second figure, the utilization of AUTISTHERAPIBOT is the main agenda.

Basically the test was carried out by allocating the first hour educating the children via the traditional method which comprised of the therapists showing each

of the color on the cardboard and then tell them the color while the children have to reiterate every shown color and then another 20 minute for a test on paper to check on whether they truly understand the idea conveyed or otherwise by coloring the mention color on the paper. After that, another 2 hours was spent on the AUTISTHERAPIBOT where the children observe the color sorting by the color sorter and then they themselves will have a chance to manually control the second robot by placing a colored ball on the lifter and then the children have to move the lifter to the appropriate colored tray and then put it into correct place to test on whether they truly comprehend the teaching material and the third robot is basically a means to make the teaching environment more interactive and entertaining for the autistic kids. The results was observed and recorded.

4.4.2 Test Results

Both the test which were the traditional approach and the AUTISTHERAPIBOT approach have been observed and the results are compared. The result are as follows in the following figure. Before the test was carried out, a pre selection test was done to make sure whether the test candidate are fit for the test of otherwise. The pre selection was done in a way where the possible candidates are asked to tinker with the three robots and check on their acceptance towards the usage of the robot. If they can handle it, then they are selected, otherwise, they are rejected. Once selected, they will go for the actual test where the therapist will assist the children to observe the color sorter and then assist them in segregating the colored object manually by using the lifter and lastly, as a reward for accomplishing the color sorting task, they are allowed to play with the fan where the fan will be triggered by any sound created by the children. The results can be shown in the figure below.

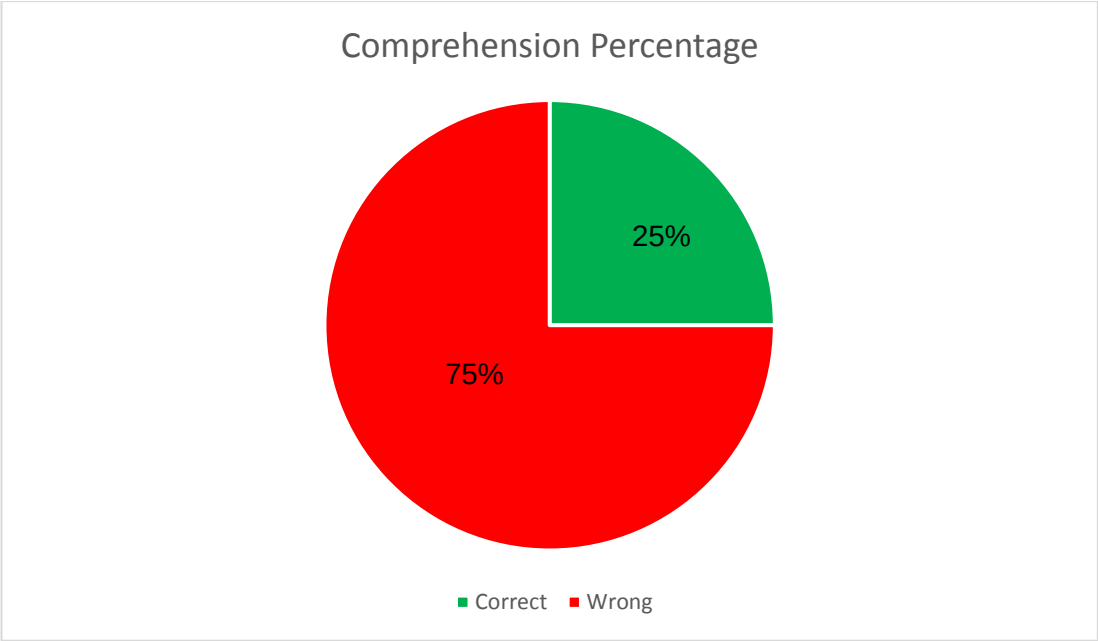


Figure 4.15: The success rate of traditional method

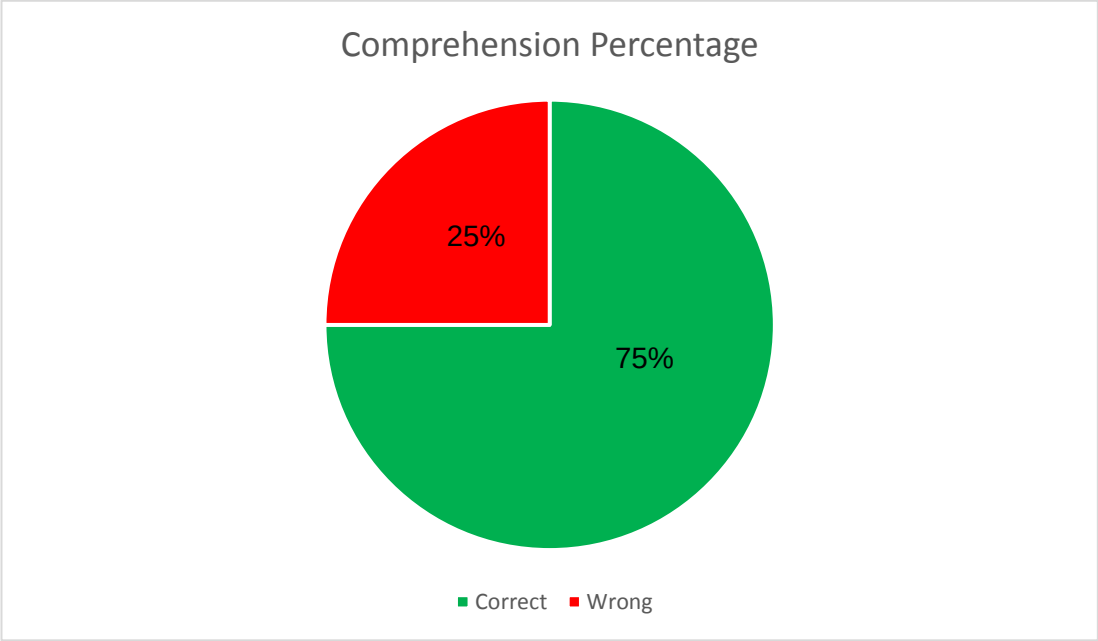


Figure 4.16: The success rate of AUTISTHERAPIBOT

As seen in the two figure above, it can be deduced that AUTISTHERAPIBOT excels in comparison to the traditional method. The success rate was determined by thorough observation and extensive recording of the score by each of the method by each of the test candidate. The score was then weighed and the average was obtained to be put into comparison. All the score recorded are attached in the appendix section.

The factor that leads to the higher success rate of learning by using AUTISTHERAPIBOT was the robot are more interactive compared to the monotonous color card method since it comprises of color sorter, the lifter, and the fan which are readily available for the kids to interact with. This complies with (Robins, et al., 2004), where he stated that robotic technology provides a platform where the user and the programmer interact with each other indirectly and yet they can comprehend each other more. In this case, AUTISTHERAPIBOT conveys what the therapist's intention and materialize in physical form so that the kids can tinker with it and understand the gist of the teaching mechanism.

Plus, since the robot also have the movement functionality (the fan), AUTISTHERAPIBOT have the capability to captivate the eye of the autistic children and maintain their interest for a long time. During the commencement of the test, even though the test session was over, they still wanted to play with AUTISTHERPIBOT due to the fact that the interactivity of the robot have a high tendency to make the kids addicted into using the robot and thus digesting information better as you can see in the figure above, they score 50% better since they can maintain information better in their brain by using this mechanism.

4.4.3 Testing at NASOM

The same test procedure as explained before in the previous section was carried out at one of National Autism Society of Malaysia's center at Bagan Ajam, Penang where 5 more autistic children were tested with AUTISTHERAPIBOT. The observation of the test was all the children were captivated with the use of all the three robot that makes up the AUTISTHERAPIBOT. The children age were around 7 to 12 years old. Three of them were hesitant at first, and when they saw the fan, they eagerly do the test where it involves the color sorter and lifter so that they can play with it. The other two were frantic in playing with all the three robot in AUTISTHERAPIBOT. There was also one additional autistic kid who want to join in the test, however the kid is a bit problematic since the kid have a combination of two learning disabilities which are autism and slow-learner which makes it rather impossible to run the test on the kid because the kid stay silent all the time without

making any movement at all. The below figure will show how the test was executed and the results of the test.

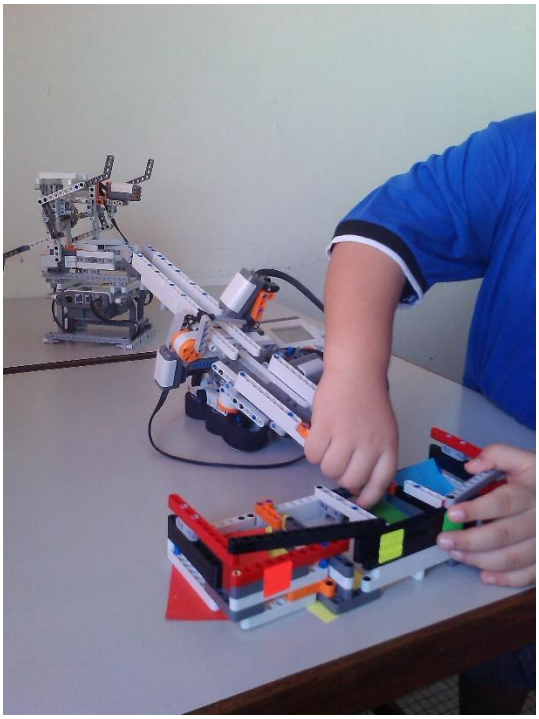


Figure 4.17: Conducting a test with an autistic children at NASOM

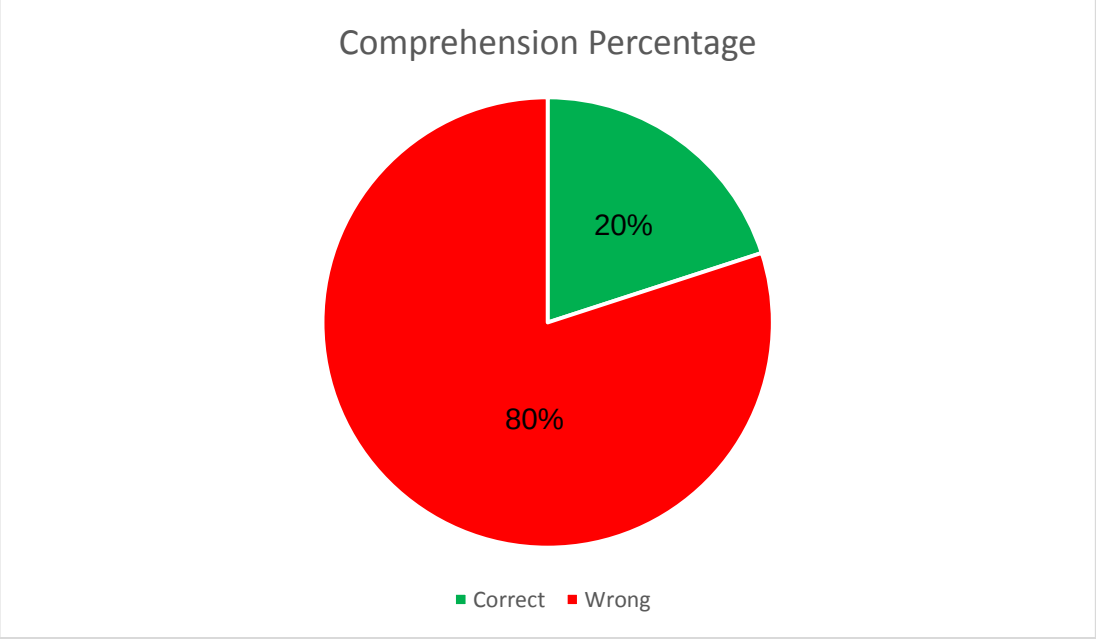


Figure 4.18: The success rate of traditional means (NASOM)

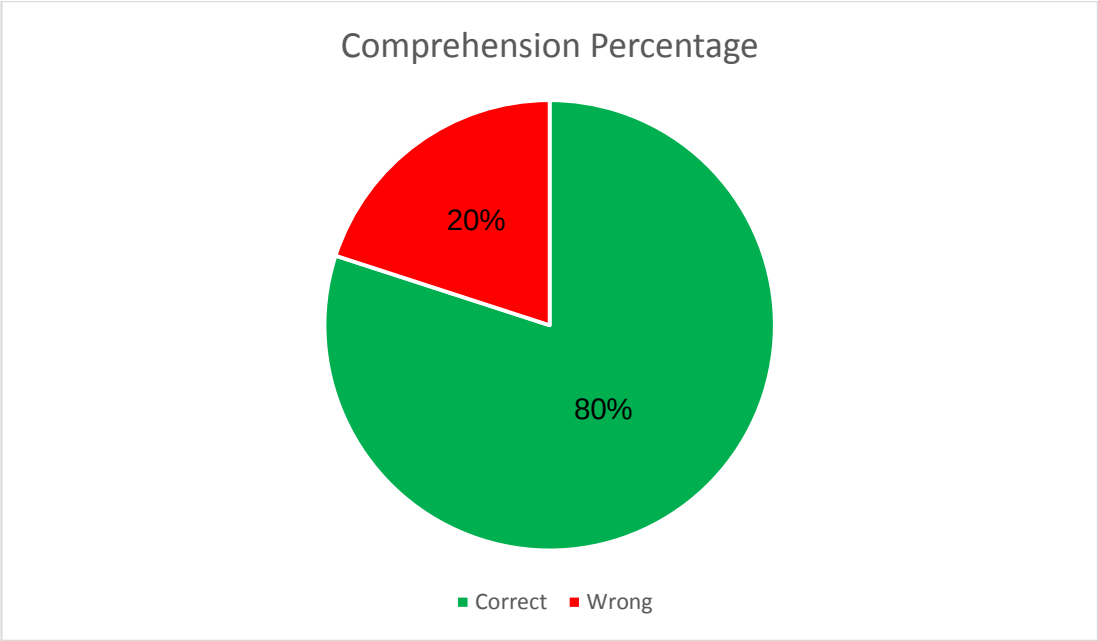


Figure 4.19: The success rate of AUTISTHERAPIBOT (NASOM)

From both the figure above, we can deduce that AUTISTHRAPIBOT have big potential in making the autistic children learning environment more interactive and exciting. As you can see, with AUTISTHERAPIBOT, it can boost the comprehension rate by average of 60% based from the test results from the testing of 5 test candidates from NASOM.

4.4.4 Color Detection

Color detection is learnt to ensure AUTISTHERAPIBOT sorts the object smoothly without errors so that it could teach proper colors to the autistic children. For this case, the color sensors were studied. Due to the class-scaled size of the prototype, the test area is assumed to be of 10m x 10m, where it should cover the whole vicinity of the autistic classroom for the autistic children to observe. The prototype functionality is shown in Figure 4.20 below.

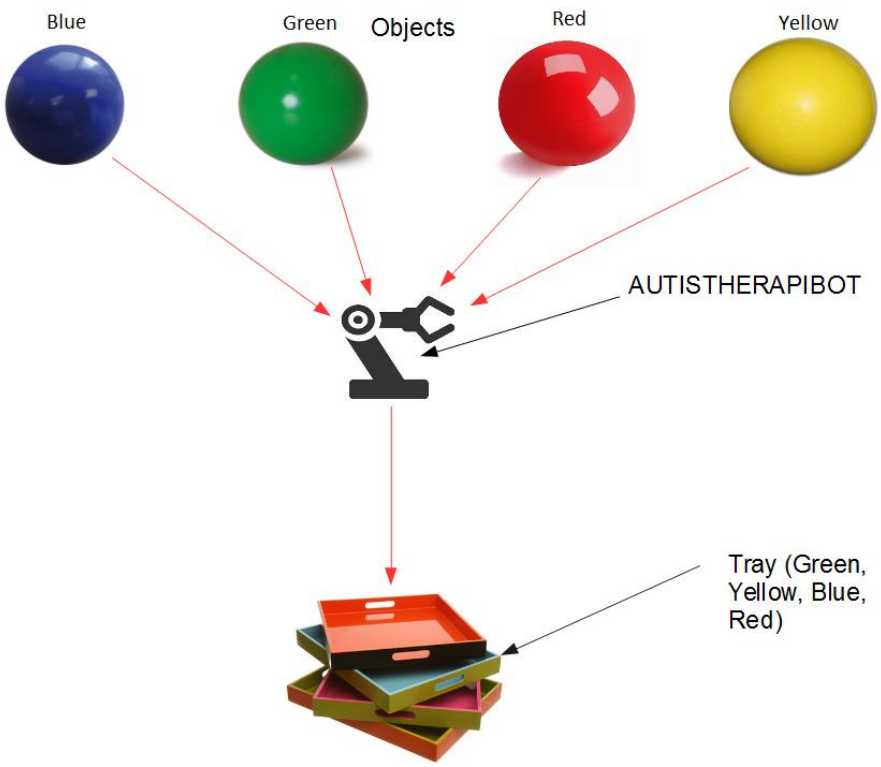


Figure 4.20: The functionality of AUTISTHERAPIBOT on the prototype vicinity

The functionality of the prototype will be programmed in such a way it will always sort the colored object to its respective color type of tray since the very objective of this robot is to encourage autistic children to learn about color. The algorithm for this functionality is shown in Figure 4.21 below.

1)Wait for object to pass through
2)Hold the passing object
3)Detect the object
4)If Color = True
5)Move motor1 X degree to right
6)Move motor2 X degree (open)
7)Else = Abort
8)If Touch = False
9)Repeat step 4-7
10)Else = Go to step 1

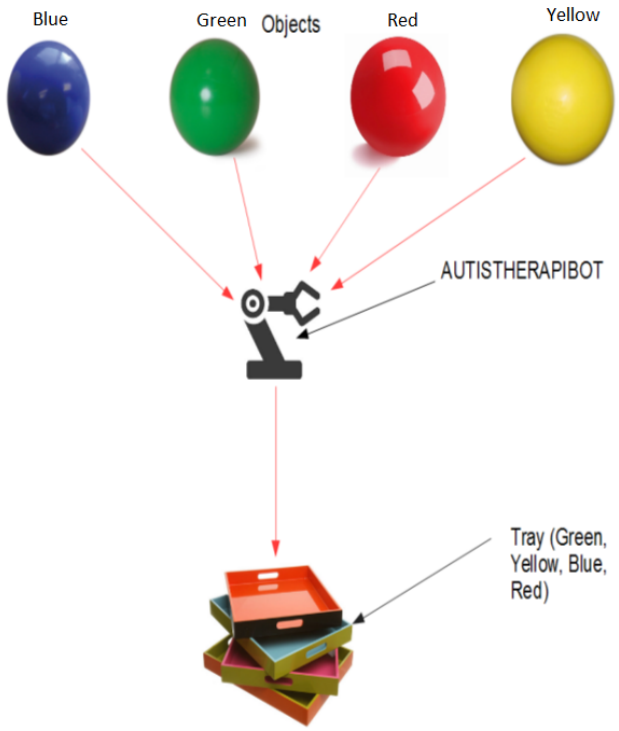


Figure 4.21: Fixed functionality of the prototype

The coding for the color detection will be preprogrammed even though the main research of AUTISTHERAPIBOT is to assist the therapists because the color avoidance will be the main catalyst to aid the therapists to teach some knowledge to the autistic children. Therefore, a fixed color detection program will be programmed followed by the fixed sorting program for the color sorting. The preprogrammed algorithm for the functionality is as shown below, which refers to the Figure 4.22 below:

1.0 Wait for object to pass through the color sensor

1.1 The degree of Motor1 (control the opening of the slot) = 0 degree

1.2 The degree of Motor2(control the alignment of slot to the tray)= 0 degree

1.3 Color = False (No color Detection)

1.4 Touch = False (No stopping Trigger)

2.0 If Color = True

2.1 If Color = Blue

2.1.1 Motor1 = 20 degree (open)

2.1.2 Motor2 = X degree

2.2 Else If Color = Red

2.2.1 Motor1 = 20 degree (open)

2.2.2 Motor2 = X - Y degree

2.3 Else If Color = Green

2.3.1 Motor1 = 20 degree (open)

2.3.2 Motor2 = X - 2Y degree

2.4 Else If Color = Yellow

2.4.1 Motor1 = 20 degree (open)

2.4.2 Motor2 = X - 3Y degree

3.0 Else Color = False

3.1 The degree of Motor1 (control the opening of the slot) = 0 degree

3.2 The degree of Motor2(control the alignment of slot to the tray)= 0 degree

4.0 If Touch = True

4.1 The degree of Motor1 (control the opening of the slot) = 0 degree

4.2 The degree of Motor2(control the alignment of slot to the tray)= 0 degree

5.0 Else Touch = False

5.1 If Color = True

5.2 If Color = Blue

5.2.1 Motor1 = 20 degree (open)

5.2.2 Motor2 = X degree

5.3 Else If Color = Red

5.3.1 Motor1 = 20 degree (open)

5.3.2 Motor2 = X - Y degree

5.4 Else If Color = Green

5.4.1 Motor1 = 20 degree (open)

5.4.2 Motor2 = X - 2Y degree

5.5 Else If Color = Yellow

5.5.1 Motor1 = 20 degree (open)

5.5.2 Motor2 = X - 3Y degree

Figure 4.22: The pseudo code of AUTISTHERAPIBOT

For the purpose of color detection, one sensor were studied, which is the color sensor. LEGO NXT color sensor detects color from an object by firing low light beam to a particular object and from the reflection of the light from the object the sensor captures the reflection, send it to the brick for computation and then send an appropriate response depending on the outcome of the computation. The sensor must be put close to the object since any interference of light or any changes in light intensity may cause error in color detection. The color sensor is shown in Figure 4.23 below.

Figure 4.23: LEGO Mindstorm NXT Color Sensor

The features of this sensor are summarized in Table 7 below.

Table 4.3: Summary of Color Sensor features

	Color Sensor
Measuring Distance	1 to 2 cm
Type of Control	Automated
Activation/ Response	Upon detection of color
Auto-ID	Built into NXT software

Based on the summary, the color sensor will be used for the construction of AUTISTHERAPIBOT. This is due to the fact that color sensor is able to detect color at high accuracy when it is put within the range of 1 to 2 cm within the object, which enables AUTISTHERAPIBOT to detect and at the same time sort the colored object into respective tray.

4.5 Summary

This chapter briefly explained on the result of the research that was done in the special school and the interview that was performed to the therapists. This is to study on the existing problem faced by both the therapists and the autistic children in terms of knowledge sharing and receiving. Results of field tests were also documented, displaying the necessity of having AUTISTHERAPIBOT. Observation was done on the behavior of the autistic children towards the current methodology of teaching practiced by the therapists to develop the functionality for the prototype. Next, surveys will be done on the therapists to ask on their feedback of AUTISTHERAPIBOT for autistic children.

CHAPTER 5: CONCLUSION AND RECOMMENDATION

5.1 Introduction

Even though the existing method of giving education to autistic students is important, failure to impart the understanding of the knowledge is becoming common among the autistic children due to lack of comprehension from both sides. This phenomenon, in some scenario can result in permanent mental breakdown that will totally shroud the autistic children's future. This project focuses on the study on the problems faced by autism therapists to convey knowledge to their respective autistic students.

5.2 Achieved Objective

The first objective of my project is to investigate the existing teaching methods used by the autism therapists at the selected special school in Perak.

Objective 1: To investigate the current teaching methods used by the autism therapists at the selected special school in Perak.

This objective has been accomplished via interviews and observations. A field visit has also been done in order to research the problems faced by both the autism therapists and the autistic students in terms of knowledge sharing. A visit to the special school has been performed to interview on the difficulties faced by the therapists in conveying the knowledge to their respective students. Besides, an observation on how the autistic children react towards the current way of teaching has been exercised to see what is the degree of efficiencies of current method of teaching that are being used by the therapists.

Objective 2: To develop an autonomous robotic system to aid the therapists in educating autistic children.

AUTISTHERAPIBOT is already been developed by the creation of the three robot mentioned previously which are the lifter, color sorter and the fan. This robot have the potential to aid the therapists and incite the children's interest due to its ergonomic feature and interactivity. Thus, this objective have been achieved.

Objective 3: To evaluate the developed prototype with the target environment namely the selected special school in Perak.

The testing of AUTISTHERAPIBOT have been carried out at Sekolah Kebangsaan Sultan Yussof in Batu Gajah and NASOM Bagan Ajam, Penang where both the test for traditional method and robotic method have been exercised and compared. After thorough observation and proper scoring, the results was obviously favoring the robotic means since it caters both the therapists and the kids' needs splendidly.

5.3 Future Work

The peripherals and functionalities utilized in AUTISTHERAPIBOT can further be improvised and upgraded for the usage of special school in a wider scale. AUTISTHERAPIBOT can be programmed to observe and assessed the level of efficiencies in knowledge sharing. Thus, this could give accurate feedback to the therapists so that they can improvise the way they teach their respective autistic students more effectively. Furthermore, new functionality can also be added to raise more potential in delivering better knowledge to the autistic children. In addition to that, cheaper materials might also be a good future work idea so that this robot can help and cover a wider range of those who are suffering from autism.

5.4 Challenges

The challenges that comes with the future work is how this robot will improve the autistic children in terms of their teamwork aspects since they are bad in terms of socializing and communicating with each other. Thus, this robot can help them if the robot such as the lifter are increased in number so that multiple children

can control the robots at one time to achieve common specific goals much like the LEGO therapy stated in the literature review but with robotic intervention.

5.5 Summary

Numerous kinds of causes to the ineffective learning in the special school have been listed down. Adding to this, the ramifications of poor understanding on the difficulties of learning faced by the autistic children has also been detected. In order to revoke this issue, studies on the existing system and applications have been exercised thoroughly. However there were advantages and setback on each of those systems, giving opportunity to filter the useful features needed for the development of AUTISTHERAPIBOT. AUTISTHERAPIBOT is able to distinguish colors, followed by sorting out the colored object to its proper destination so that it can aid the therapists on teaching their students on proper colors. The significance of this project is it provides an aid for the therapists to teach yet creating an interactive environment for autistic children to learn. This ensures swifter rate of learning by the autistic students and at the same time reduces the risk faced by the therapists in confronting these children.

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PUBLISHES

This Research Paper will soon be published at IEEE ROMA 2014 in Kuala Lumpur on 15-16 December 2014.

APPENDICES

APPENDIX I: Approval Letter from Ministry of Education

BAHAGIAN PERANCANGAN DAN PENYELIDIKAN DASAR PENDIDIKAN
KEMENTERIAN PENDIDIKAN MALAYSIA
ARAS 1-4, BLOK E-8
KOMPLEKS KERAJAAN PARCEL E
PUSAT PENTADBIRAN KERAJAAN PERSEKUTUAN
62604 PUTRAJAYA

Telefon : 03-8884591
Faks : 03-8884579

Ruj. Kami : KP(BPPDP)603/5/JLD. 16(180)
Tarikh : 30 Jun 2014

Norshuhani binti Zamin
Universiti Teknologi Petronas
Bandar Seri Iskandar
31750 Tronoh
Perak

Tuan/Puan,

Kelulusan Khas Untuk Menjalankan Kajian Di Sekolah, Institut Pendidikan Guru, Jabatan Pendidikan Negeri Dan Bahagian-bahagian Di Bawah Kementerian Pendidikan Malaysia

Adalah saya dengan hormatnya diarah memaklumkan bahawa permohonan tuan/puan untuk menjalankan kajian bertajuk

"Robotic Application as Therapeutic Aid for Children with Learning Disabilities" diluluskan.

2. Kelulusan ini adalah berdasarkan kepada cadangan penyelidikan dan instrumen kajian yang tuan/puan kemukakan ke Bahagian ini. **Kebenaran bagi menggunakan sampel kajian perlu dipohon dari Ketua Bahagian/Pengarah Pendidikan.**

3. Sila tuan/puan kemukakan ke Bahagian ini senaskhah laporan akhir kajian/laporan dalam bentuk elektronik berformat Pdf di dalam CD bersama naskhah *hardcopy* setelah selesai kelak. Tuan/Puan juga dingatkan supaya mendapat kebenaran terlebih dahulu daripada Bahagian ini sekiranya sebahagian atau sepenuhnya dapatan kajian tersebut hendak dibentangkan di mana-mana forum atau seminar atau diumumkan kepada media massa.

Sekian untuk makluman dan tindakan tuan/puan selanjutnya. Terima kasih.

"BERKHIDMAT UNTUK NEGARA"

Saya yang menurut perintah,

(DR HJ ZA[illegible]I BIN DARUS)
Ketua Sektor
Sektor Penyelidikan dan Penilaian
b.p. Pengarah
Bahagian Perancangan dan Penyelidikan Dasar Pendidikan
Kementerian Pendidikan Malaysia

APPENDIX II: Approval Letter for NASOM

UNIVERSITI
TEKNOLOGI
PETRONAS

NASOM@Butterworth
No 8, Lorong Molek 3,
Bagan Ajam
13000, Butterworth, Penang.

14 Oktober 2014

Tuan / Puan,

Permohonan untuk Menggunakan Sampel Kajian di NASOM, Butterworth.

Saya sebagai ketua penyelidik untuk sebuah projek pelajar tahun akhir daripada Jabatan Komputer dan Sains Maklumat, UTP ingin memohon jasa baik pihak tuan untuk membenarkan kami menjalankan kajian rintis dan seterusnya menjalankan ujikaji ke atas pelajar-pelajar yang terpilih. Maklumat penyelidikan adalah seperti berikut:

Tajuk: Robotic Application as Therapeutic Aid for Children with Learning Disabilities.
Tempoh: Mei-Disember 2014
Nama Pelajar: Muhamad Haris Bin Abdul Rahim

2. Tujuan utama penyelidikan ini adalah untuk membantu kanak-kanak yang mempunyai masalah pembelajaran melalui pendekatan robotik. Kajian 'pilot' perlu dilaksanakan ke atas sekumpulan pelajar dan maklumat berkenaan pelajar ini perlu kami perolehi. Namun begitu, semua maklumat ini akan dirahsiakan dan tidak akan dibentangkan di mana-mana persidangan. Aplikasi robotik yang telah dibangunkan akan dipersembahkan kepada pihak tuan / puan dan akan digunakan sebagai alat ujikaji untuk menguji keberkesanannya sebagai alat bantuan mengajar yang lebih efektif dan inovatif.

4. Saya berharap permohonan ini mendapat pertimbangan dan kelulusan daripada pihak tuan dengan kadar segera.

Sekian, terima kasih.

Yang Benar,

Dr. Norshuhani Zamin
Pensyarah / Ketua Penyelidik Projek Tahun Akhir
Jabatan Komputer dan Sistem Maklumat
Fakulti Sains dan Teknologi Maklumat

APPENDIX III: Interview Questions

FYP1 RESEARCH QUESTIONNAIRE

Name :

Occupation :

Contact Number :

E-mail Address :

1. From your own experiences or observations, what causes autism?

_____

_____

_____

_____

_____

_____

_____

2. From your point of view, what is autism? What is the standard characteristics that always being displayed by those children with autism?

_____

_____

_____

_____

_____

_____

_____

_____

_____

3. Is there any abrupt action (eccentric behavior) from children with autism? If so, please clarify the behavior and explain why it happen.

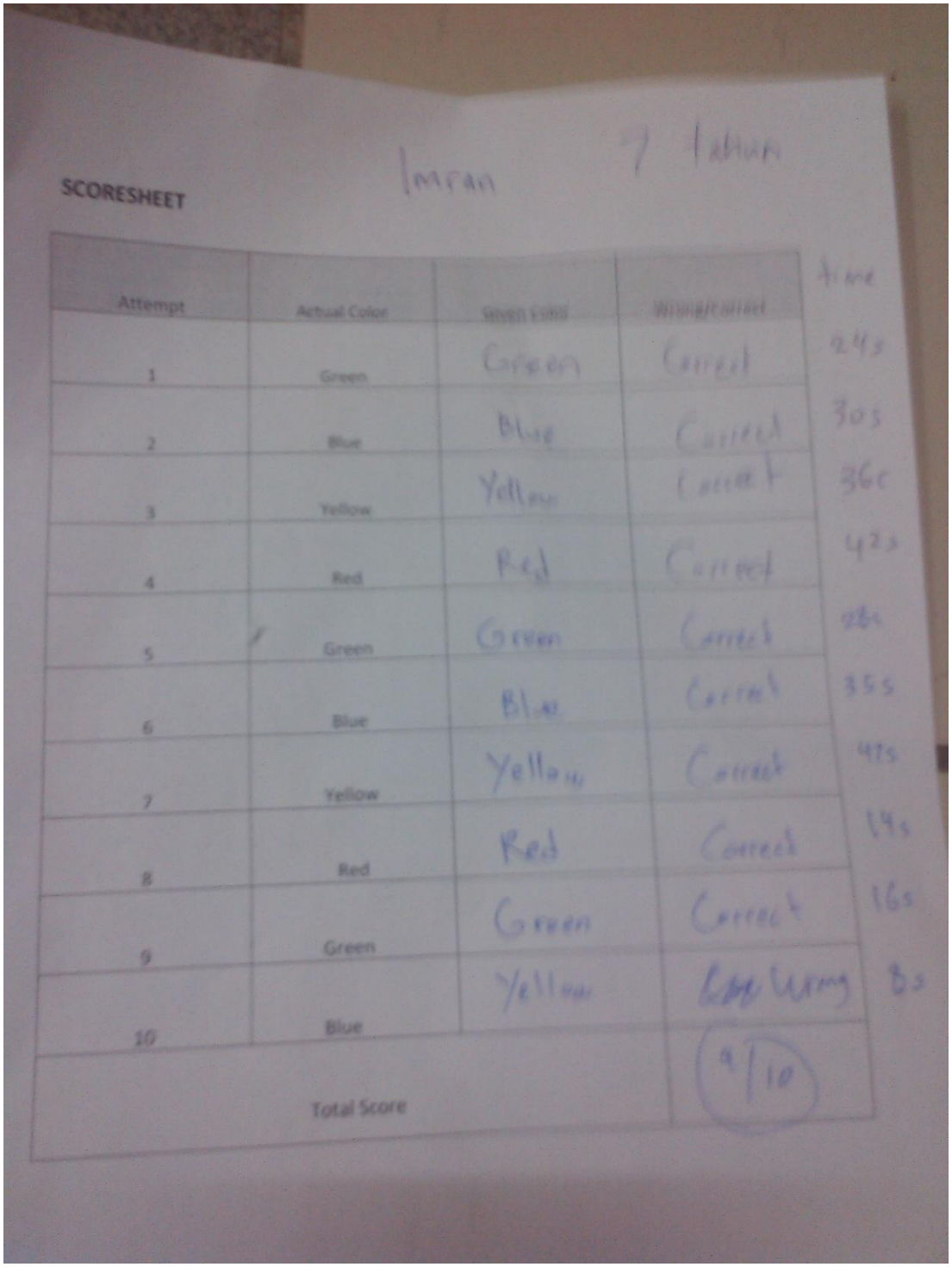
_____

_____

_____

_____

APPENDIX IV: Test Score Sheets

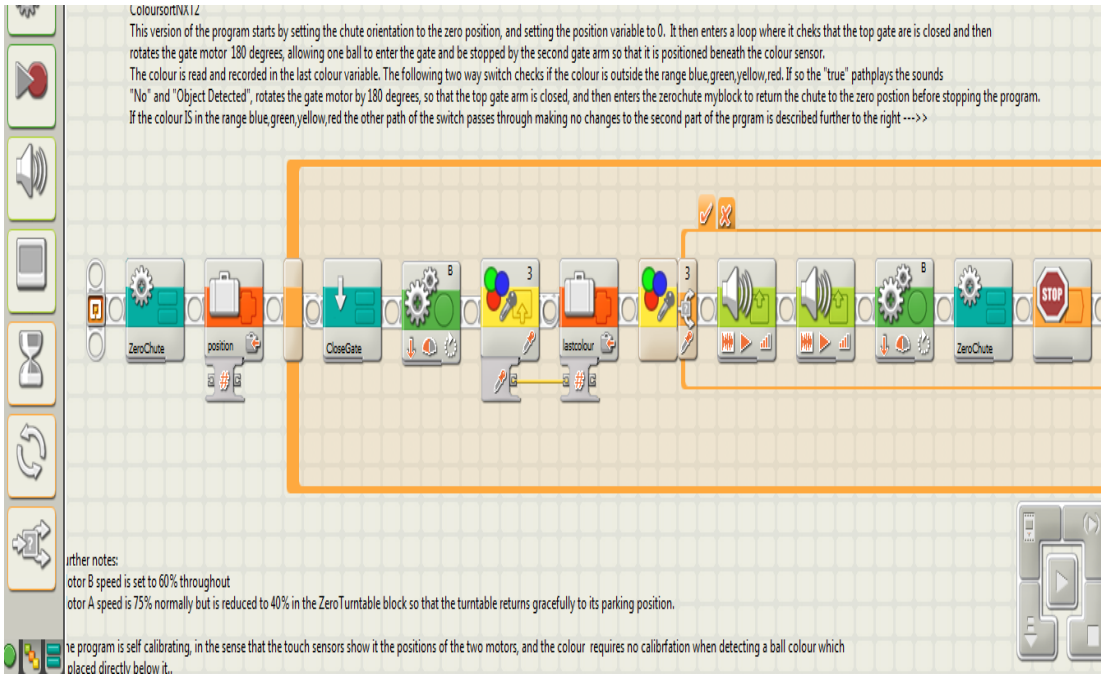


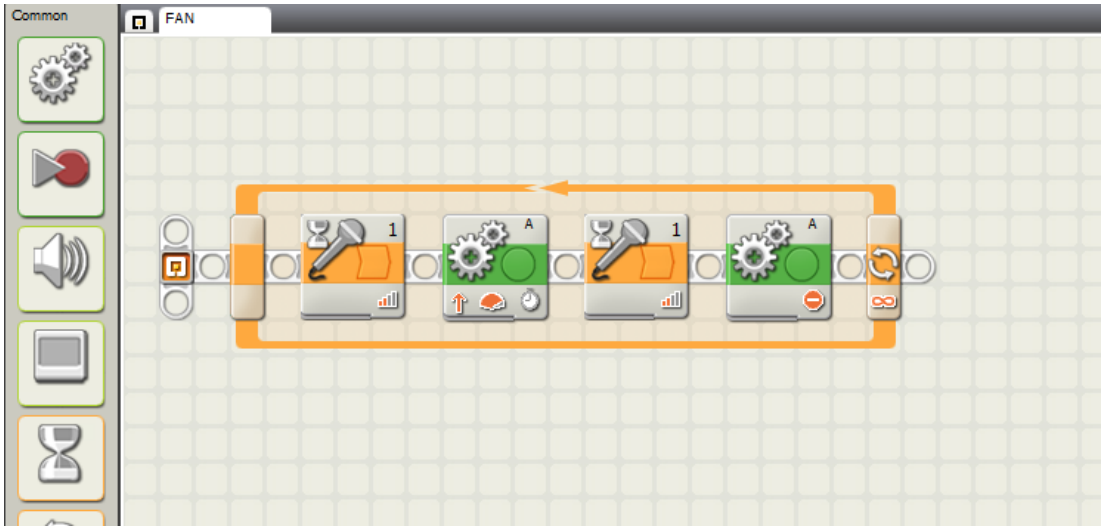
SCORESHEET

Imran 7 Fathun

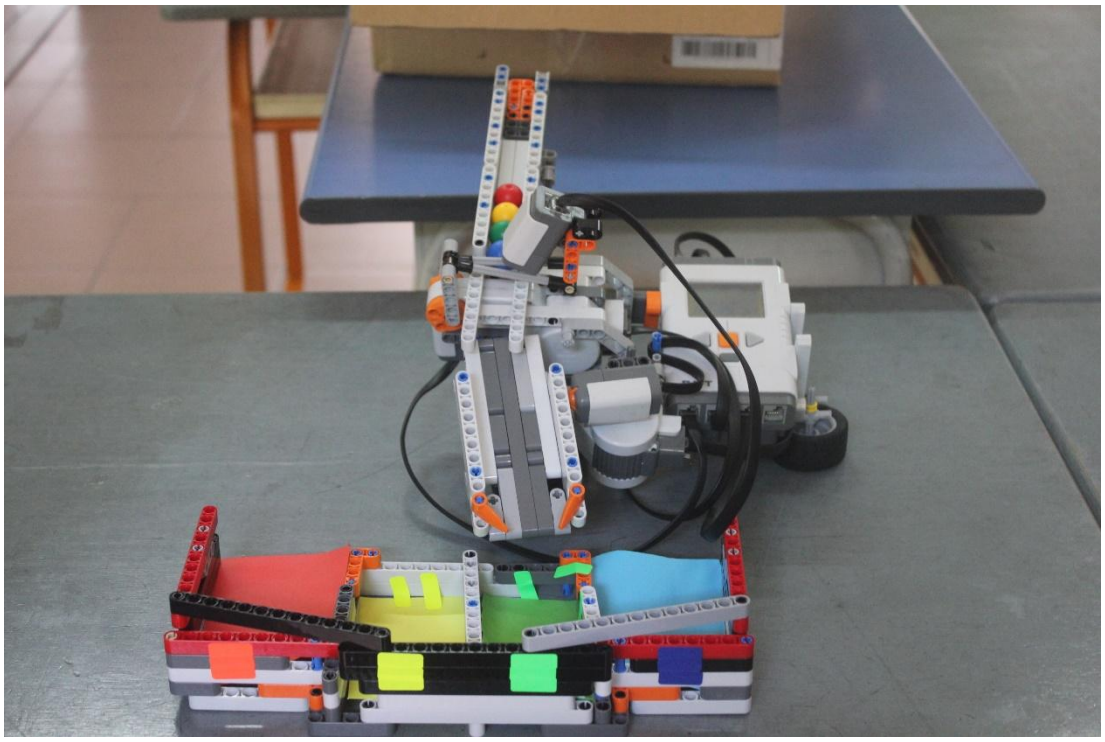
Attempt	Actual Color	Given Color	Wrong/Correct	Time
1	Green	Green	Correct	24s
2	Blue	Blue	Correct	30s
3	Yellow	Yellow	Correct	36s
4	Red	Red	Correct	42s
5	Green	Green	Correct	28s
6	Blue	Blue	Correct	35s
7	Yellow	Yellow	Correct	49s
8	Red	Red	Correct	14s
9	Green	Green	Correct	16s
10	Blue	Yellow	Wrong	8s
Total Score			9/10	

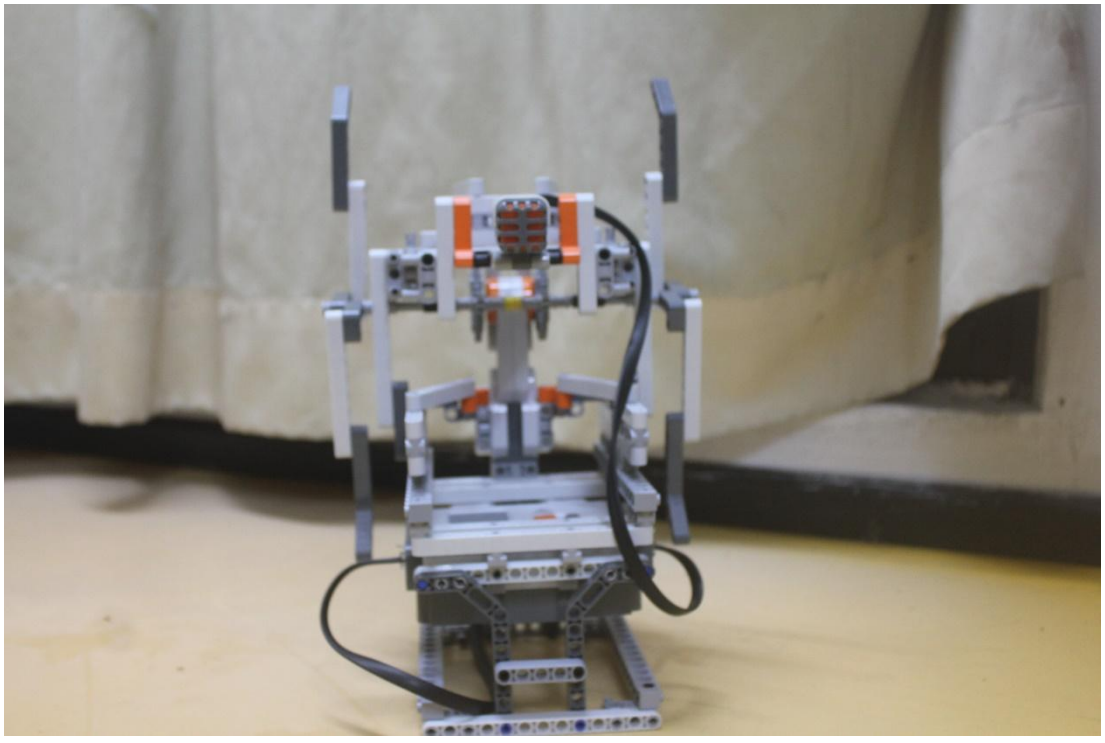
APPENDIX V: Code Snippet





APPENDIX VI: The Prototype






NXT